PAMPHLETS.

Entomology.

Insects

GUIDE TO THE STUDY OF INSECTS.

THE CLASS OF INSECTS.

THAT branch of the Animal Kingdom known as the ARTICULATA, is so called from having the body composed of rings or segments, like short cylinders, which are placed successively one behind the other. Cuvier selected this term because he saw that the plan of their entire organization, the essential features which separate them from all other animals, lay in the idea of articulation, the apparent joining together of distinct segments along the line of the body. If we observe carefully the body of a Worm, we shall see that it consists of a long cylindrical sac, which at regular intervals is folded in upon itself, thus giving a ringed (annulated, or articulated) appearance to the body. In Crustaceans (crabs, lobsters, etc.) and in Insects, from the deposition of a peculiar chemical substance called *chitine*, the walls of the body become so hardened, that when the animal is dead and dry, it readily breaks into numerous very perfect rings.


Fig. 1.

Though this branch contains a far greater number of species than any other of the animal kingdom, its myriad forms can all be reduced to a simple, ideal, typical figure; that of a long slender cylinder divided into numerous segments, as in Fig. 1, representing the larva of a Fly. It is by the unequal development and the various modes of grouping them, as well as the differences in the number of the rings themselves, and also in the changes of form of their appendages, *i.e.* the feet, jaws, antennæ, and wings, that the various forms of Articulates are produced.

FIG. 1. Worm-like larva of a Fly, *Scenopinus*.—*Original*.

Articulated animals are also very distinctly *bilateral*, *i.e.* the body is symmetrically divided into two lateral halves, and not only the trunk but the limbs also show this *bilateral symmetry.* In a less marked degree there is also an *antero-posterior symmetry*, *i.e.* each end of the body is opposed, just as each side of the body is, to the other.* The line separating the two ends is, however, imaginary and vague. The antennæ, on the anterior pole, or head, are represented by the caudal, or anal, stylets (Fig. 2), and the single parts on the median line of the body correspond. Thus the labrum and clypeus are represented by the tergite of the eleventh segment of the abdomen.

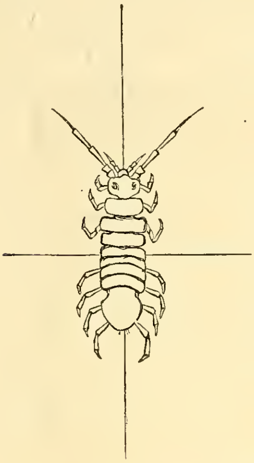


Fig. 2.*

In all Articulates (Fig. 3) the long, tubular, alimentary canal occupies the centre of the body; above it lies the "heart," or dorsal vessel, and below, upon the under side, rests the nervous system. The breathing apparatus, or "lungs," in Worms consists of simple filaments, placed on the front of the head; or of gill-like processes, as in the Crustaceans, which are formed by membranous expansions of the legs; or, as in the Insects (Fig. 4), of delicate tubes (tracheæ), which

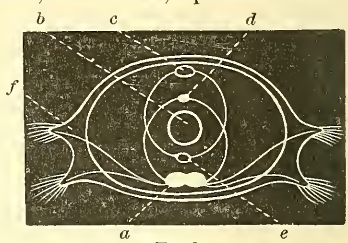


Fig. 3.

* Professor Wyman (On Symmetry and Homology in Limbs, Proceedings of the Boston Society of Natural History, 1867) has shown that antero-posterior symmetry is very marked in Articulates. In the adjoining figure of *Jæra* (Fig. 2) the longitudinal lines illustrate what is meant by bilateral symmetry, and the transverse lines "fore and aft" symmetry. The two antero-posterior halves of the body are very symmetrical in the Crustacean genera *Jæra*, *Oniscus*, *Porcellio*, and other Crustacea, and also among the Myriapods, *Scutigera*, *Polydesmus*, "in which the limbs are repeated oppositely, though with different degrees of inequality, from the centre of the body backwards and forwards." "Leuckart and Van Beneden have shown that Mysis has an ear in the last segment, and Schmidt has described an eye in the same part in a worm, *Amphicora*."—*From Wyman.*

FIG. 3 represents an ideal section of a Worm. *f* indicates the skin, or muscular body-wall, which on each side is produced into one or more fleshy tubercles, usually tipped with bristles or hairs, which serve as organs of locomotion, and

ramify throughout the whole interior of the animal, and connect with breathing pores (stigmata) in the sides of the body. They do not breathe through the mouth as do the higher animals. The tracheæ and blood-vessels follow closely the same

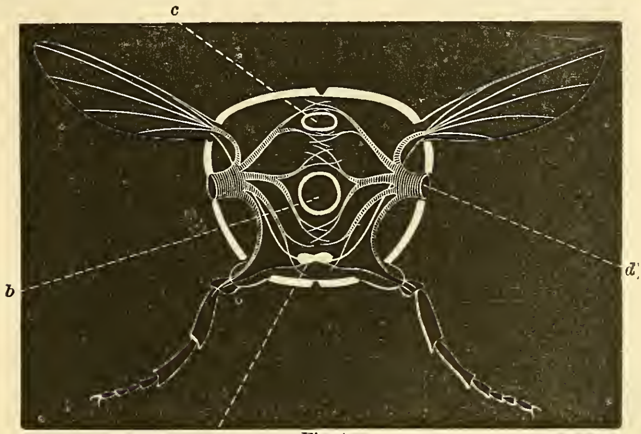


Fig. 4.

course, so that the aëration of the blood goes on, apparently, over the whole interior of the body, not being confined to a single region, as in the lungs of the vertebrate animals.

Thus it is by observing the general form of the body-walls, and the situation of the different anatomical systems, both in relation to themselves and the walls of the body, or crust, which surrounds and protects the more delicate organs within, that we are able to find satisfactory characters for isolating, in our definitions, the articulates from all other animals.

We shall perceive more clearly the differences between the three classes of Articulates, or jointed animals, namely, the WORMS, CRUSTACEANS, and INSECTS, by examining

often as lungs. The nervous cord (*a*) rests on the floor of the cylinder, sending a filament into the oar-like feet (*f*), and also around the intestine or stomach (*b*), to a supplementary cord (*d*), which is situated just over the intestine, and under the heart or dorsal vessel (*c*). The circle *c* and *e* is a diagram of the circulatory system; *c* is the dorsal vessel, or heart, from the side of which, in each ring, a small vessel is sent downwards and around to *e*, the ventral vessel.— *Original.*

FIG. 4. An ideal section of a Bee. Here the crust is dense and thick, to which strong muscles are attached. On the upper side of the ring the wings grow out, while the legs are inserted near the under side. The tracheæ (*d*) enter through the *stigma*, or breathing pore, situated just under the wing, and their branches subdivide and are distributed to the wings, with their five principal veins as indicated

their young stages, from the time of their exclusion from the egg, until they pass into mature life. A more careful study of this period than we are now able to enter upon would show us how much alike the young of all articulates are at first, and how soon they begin to differ, and assume the shape characteristic of their class.

Most Worms, after leaving the egg, are at first like some infusoria, being little sac-like animalcules, often ciliated over nearly the entire surface of the infinitesimal body. Soon this sac-like body grows longer, and contracts at intervals; the intervening parts become unequally enlarged, some segments, or rings, formed by the contraction of the body-walls, greatly exceeding in size those next to them; and it thus assumes the appearance of being more or less equally ringed, as in the young *Terebella* (Fig. 5), where the ciliæ are restricted to a single circle surrounding the body. Gradually (Fig. 6) the ciliæ disappear and regular locomotive organs, consisting of minute paddles, grow out from each side; feelers (antennæ), jaws, and eyes (simple rudimentary eyes) appear on the few front rings of the body, which are grouped by themselves into a sort of head, though it is difficult, in a large proportion of the lower worms, for unskilled observers to distinguish the head from the tail.

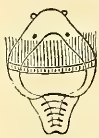


Fig. 5.

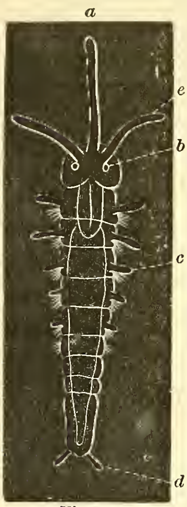


Fig. 6.

Thus we see throughout the growth of the worm, no attempt at subdividing the body into regions, each endowed with its peculiar functions; but only a more perfect system of rings, each relatively very equally developed,

in the figure, also to the dorsal vessel (c), the intestine (b), and the nervous cord (a). The tracheæ and a nervous filament are also sent into the legs and to the wings. The tracheæ are also distributed to the dorsal vessel and intestine by numerous branches which serve to hold them in place. — *Original.*

FIG. 5. Young *Terebella*, soon after leaving the egg. — *From A. Agassiz.*

FIG. 6 represents the embryo of a worm (*Autolytus cornutus*) at a later stage of growth. *a* is the middle tentacle of the head; *e*, one of the posterior tentacles; *b*, the two eye-spots at the base of the hinder pair of feelers; *c* is one of a row of oar-like organs (*cirri*) at the base of which are inserted the locomotive bristles,

but all becoming respectively more complicated. For example, in the Earth-worm (*Lumbricus*), each ring is distinguishable into an upper and under side, and in addition to these a well-marked side-area, to which, as for example in marine worms (e. g. *Nereis*), oar-like organs are attached. In most worms eye-spots appear on the front rings, and slender tentacles grow out, and a pair of nerve-knots (ganglia) are apportioned to each ring.

In the Crustaceans, such as the fresh-water Crawfish (*Astacus*), as shown by the German naturalist Rathke; and also in the earliest stages of the Insect, the body *at once* assumes a worm-like form, thus beginning its embryonic life from the goal reached by the adult worm.

The young of all Crustaceans (Fig. 7) first begin life in the egg as oblong flattened worm-like bodies, each end of the body being alike. The young of the lower Crustaceans, such as the Barnacles, and some marine forms like the *Jæra* and some lowly organized parasitic species inhabiting the gills of fishes, are hatched as microscopic embryos which would readily be mistaken for young mites (*Acarina*). In the higher Crustaceans, such as the fresh-water Crawfish, the young, when hatched, does not greatly differ from the parent, as it has passed through the worm-like stage within the egg.

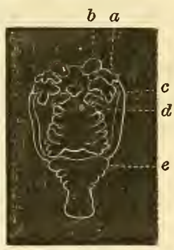


Fig. 7.

Fig. 7 represents the young of the fresh-water Lobster (Crawfish) before leaving the egg. The body is divided into rings, ending in lobes on the sides, which are the rudiments of the limbs. *b* is the rudiment of the eye-stalk, at the end of which is the eye; *a* is the fore antennæ; *c* is the hind antennæ; *d* is one of the maxilla-feet; *e* is the first pair of true feet destined in the adult to form the large "claw." Thus the eye-stalks, antennæ, claws, and legs are moulded upon a common form, and at first are scarcely distin-

with the cirri serving as swimming and locomotive organs; *d*, the caudal styles, or tail-feelers. In this figure we see how slight are the differences between the feelers of the head, the oar-like swimming organs, and the caudal filaments; we can easily see that they are but modifications of a common form, and all arise from the common limb-bearing region of the body. The alimentary canal, with the proventriculus, or anterior division of the stomach, occupies the middle of the body; while the mouth opens on the under side of the head.—*From A. Agassiz.*

FIG. 7. Embryo of the Crawfish.—*From Rathke.*

guishable from each other. Here we see the embryo divided into a head-thorax and a tail.

It is the same with Insects. Within the egg at the dawn of life they are flattened oblong bodies curved upon the yolk-mass. Before hatching they become more cylindrical, the limbs bud out on the sides of the rings, the head is clearly demarked, and the young caterpillar soon steps forth from the egg-shell ready armed and equipped for its riotous life.

As will be seen in Fig. 8, the legs, jaws, and antennæ are first started as buds from the side of the rings, being simply elongations of the body-wall, which bud out, become larger, and finally jointed, until the buds arising from the thorax or abdomen become legs, those from the base of the head become jaws, while the antennæ and palpi sprout out from the front rings of the head. Thus while the bodies of all articulates are built up from a common embryonic form, their appendages, which are so diverse, when we compare a Lobster's claw with an Insect's antenna, or a Spider's spinneret with the hinder limbs of a Centipede, are yet but modifications of a common form, adapted for the different uses to which they are put by these animals.

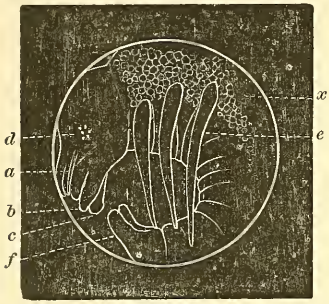


Fig. 8.

Fig. 8. A Caddis, or Case-fly (*Mystacides*) in the egg, with part of the yolk (x) not yet inclosed within the body-walls. a, antennæ; between a and b the mandibles; b, maxilla; c, labium; d, the separate eye-spots (ocelli), which afterwards increase greatly in number and unite to form the compound eye. The "neck" or junction of the head with the thorax is seen at the front part of the yolk-mass; e, the three pairs of legs, which are folded once on themselves; f, the pair of anal legs attached to the tenth ring of the abdomen, as seen in caterpillars, which form long antenna-like filaments in the Cockroach and May-fly, etc. The rings of the body are but partially formed: they are cylindrical, giving the body a worm-like form. Here, as in the other two figures, though not so distinctly seen, the antennæ, jaws, and last pair of abdominal legs are modifications of but a single form, and grow out from the side of the body. The head-appendages are directed forwards, as they are to be adapted for sensory and feeding purposes; the legs are directed downwards, since they are to support the insect while walking. It appears that the two ends of the body are perfected before the middle, and the under side before the upper, as we see the yolk-mass is not yet inclosed and the rings not yet formed above. Thus all articulates differ from all vertebrates in having the yolk-mass situated on the back, instead of on the belly, as in the chick, dog, or human embryo.—*From Zaddach.*

The Worm is long and slender, composed of an irregular number of rings, all of very even size. Thus, while the *size* of the rings is fixed, their *number* is indeterminate, varying from twenty to two hundred or more. The outline of the body is a *single* cylindrical figure. The organs of locomotion are fleshy filaments and hairs (Fig. 2, *f*) appended to the sides.

In one of the low intestinal worms, the Tape-worm (*Tœnia*), each ring, behind the head and "neck," is provided with organs of reproduction, so that when the body becomes broken up into its constituent elements, or rings (as often occurs naturally in these low forms for the more ready propagation of the species, since the young are exposed to many dangers while living in the intestines of animals), they become living independent beings which "move freely and somewhat quickly like Leaches," and until their real nature was known they were thought to be worms. This and other facts prove, that, in the Worm, the vitality of the animal is very equally distributed to each ring. If we cut off the head or tail of some of the low worms, such as the Flat Worms (*Planaria*, etc.), the pieces will become a distinct animal, but an Insect or Crab sooner or later dies when deprived of its head or tail (abdomen).

Thus, in the Worm the vital force is very equally distributed to each zoölogical element, or ring of the body; no single part of the body is much honored above the rest, so as to subordinate and hold the other parts in subservience to its peculiar and higher ends in the animal economy.

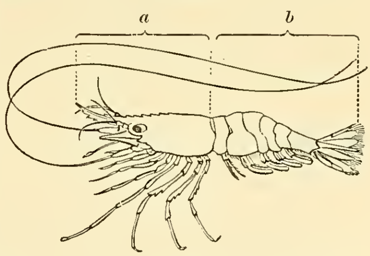


Fig. 9.

The Crustacean, of which the Shrimp (Fig. 9) is a typical example, is composed of a determinate number (21) of rings which are gathered into two regions; the head-thorax (cephalothorax) and hind-body, or abdomen. In this class there is a broad distinction between the anterior and posterior ends of the body. The rings are now grouped into two regions, and the hinder division is subordinate in its structure and

FIG. 9. A Shrimp. *Pandalus annulicornis.* *a*, cephalothorax; *b*, abdomen.

uses to the forward portion of the body. Hence the nervous power is transferred in some degree towards the head; the cephalothorax containing the nervous centres from which nerves are distributed to the abdomen. Nearly all the organs performing the functions of locomotion and sensation reside in the front region; while the vegetative functions, or those concerned in the reproduction and nourishment of the animal, are mostly carried on in the hinder region of the body (the abdomen).

The typical Crustacean cannot be said to have a true head, in distinction from a thorax bearing the organs of locomotion, but rather a group of rings, to which are appended the organs of sensation and locomotion. Hence we find the appendages of this region gradually changing from antennæ and jaws to foot-jaws, or limbs capable of eating and also of locomotion; they shade into each other as seen in Fig. 9. Sometimes the jaws become remarkably like claws; or the legs resemble jaws at the base, but towards their tips become claw-like; gill-like bodies are sometimes attached to the foot-jaws, and thus, as stated by Professor J. D. Dana in the introduction to his great work on the Crustacea of the United States Exploring Expedition, the typical Crustaceans do not have a distinct head, but rather a "head-thorax" (cephalothorax).

When we rise a third and last step into the world of Insects, we see a completion and final development of the articulate plan which has been but obscurely hinted at in the two lowest classes, the Worms and Crustaceans. Here we first meet with a true head, separate in its structure and functions from the thorax, which, in its turn, is clearly distinguishable from the third region of the body, the abdomen, or hind-body. These three regions, as seen in the Wasp (Fig. 10), are each provided with three distinct sets of organs, each having distinct functions, though all are governed by and minister to the brain force, now in a great measure gathered up from the posterior rings of the body, and in a more concentrated form (the brain being larger than in the lower articulates) lodged in the head.

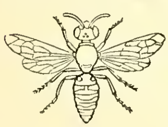


Fig. 10.

Here, then, is a centralization of parts headwards; they are

FIG. 10. *Philanthus ventilabris* Fabr. A Wood-wasp.—*From Say.*

brought as if towards a focus, and that focus the head, which is the meaning of the term "cephalization," proposed by Professor Dana.* *Ring* distinctions have given way to *regional* distinctions. The former characterize the Worm, the latter the Insect. In other words, the division of the body into three parts, or regions, is in the insect, on the whole, better marked than the division of any one of those parts, except the abdomen, into rings.

COMPOSITION OF THE INSECT-CRUST. Before describing the composition of the body-wall, or crust, of the Insect, let us briefly review the mode in which the same parts are formed in the lower classes, the Worms and Crustaceans. We have seen that the typical ring, or segment (called by authors *zoönule*, *zoönite*, or *somite*, meaning parts of a body, though we prefer the term *arthromere*, denoting the elemental part of a jointed or articulate animal), consists of an upper (tergite), a side (pleurite), and an under piece (sternite). This is seen in its greatest simplicity in the Worm (Fig. 2), where the upper and ventral arcs are separated by the *pleural region*. In the Crustacean the parts, hardened by the deposition of chitine and therefore thick and unyielding, have to be farther subdivided to secure the necessary amount of freedom of motion to the body and legs. The upper arc not only covers the back of the animal, but extends down the sides; the legs are jointed to the *epimera*, or flanks, on the lower arc; the *episternum* is situated between the epimerum and sternum; and the sternum, forming the breast, is situated between the legs. In the adult, therefore, each elemental ring is composed of six pieces. It should, however, be borne in mind that the tergum and ster-

* In two papers on the Classification of Animals, published in the *American Journal of Science and Arts*, Second Series, vol. xxxv, p. 65, vol. xxxvi, July, 1863, and also in his earlier paper on Crustaceans, "the principle of cephalization is shown to be exhibited among animals in the following ways:

1. By a transfer of members from the *locomotive* to the *cephalic* series.

2. By the anterior of the locomotive organs participating to some extent in cephalic functions.

3. By increased abbreviation, concentration, compactness, and perfection of structure, in the parts and organs of the anterior portion of the body.

4. By increased abbreviation, condensation, and perfection of structure in the posterior, or gastric and caudal portion of the body.

5. By an upward rise in the cephalic end of the nervous system. This rise reaches its extreme limit in Man."

num each consist, in the embryo, of two lateral parts, or halves, which, during development, unite on the median line of the body. Typically, therefore, the crustacean ring consists primarily of eight pieces. The same number is found in all insects which are wingless, or in the larva and pupa state; this applies also to the Myriapods and Spiders.

In the Myriapoda, or Centipedes, the broad tergum overlaps the small epimera, while the sternum is much larger than in the Spiders and Insects. In this respect it is like the broad flat under-surface of most worms. Hence the legs of the Centipede are inserted very far apart, and the "breast," or sternum, is not much smaller than the dorsal part of the crust. In the *Julus* the dorsal piece (tergum) is greatly developed over the sternum, but this is a departure from what is apparently the more typical form of the order, *i. e.* the Centipede. In the Spiders there is a still greater disproportion in size between the tergum and the sternum, though the latter is very large compared with that of Insects. The epimera and episterna, or side-pieces of the Spiders, are partially concealed by the over-arching tergum, and they are small, since the joints of the legs are very large, Audouin's law of development in Articulates showing that one part of the insect crust is always developed at the expense of the adjoining part. In the Spider we notice that the back of the thorax is a single solid plate consisting originally of four rings consolidated into a single hard piece. In like manner the broad solid sternal plate results from the reunion of the same number of sternites corresponding, originally, to the number of thoracic legs. Thus the whole upper side of the head and thorax of the Spider is consolidated into a single hard horny immovable plate, like the upper solid part of the cephalothorax of the Crab or Shrimp. Hence the motions of the Spiders are very stiff compared with those of many Insects, and correspond to those of the Crab.

The crust of the winged insect is modified for the performance of more complex motions. It is subdivided in so different a manner from the two lower orders of the class, that it would almost seem to have nothing in common, structurally speaking, with the groups below them. It is only by examin-

ing the lowest wingless forms such as the Louse, Flea, *Podura*, and Bark-lice, where we see a transition to the Orders of Spiders and Myriapods, that we can perceive the plan pervading all these forms, uniting them into a common class.

A segment of a winged six-footed insect (Hexapod) consists typically of eight pieces which we will now examine more leisurely. Figure 12 represents a side-view of the thorax of the *Telea Polyphemus*, or Silkworm moth, with the legs and wings removed. Each ring consists primarily of the *tergum*, the two side-pieces (epimerum and episternum) and the *sternum*, or breast-plate. But one of these pieces (sternum) remains simple, as in the lower orders. The tergum is divided into four pieces. They were named by Audouin going from before backwards, the *præscutum*, *scutum*, *scutellum*, and *postscutellum*.

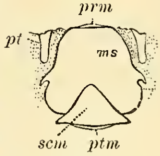


Fig. 11.

The scutum is invariably present and forms the larger part of the upper portion (tergum) of the thorax; the scutellum is, as its name indicates, the little shield so prominent in the beetle, which is also uniformly present. The other two pieces are usually minute and crowded down out of sight, and placed between the two opposing rings. As seen in Fig. 11, the præscutum of the moth is a small rounded piece, bent vertically down, so as not to be seen from above. In the lowly organized *Hepialus*, and some

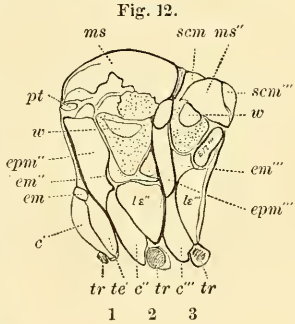
Fig. 12.


FIG. 11. Tergal view of the middle segment of the thorax of *Telea Polyphemus*. *prm*, præscutum; *ms*, scutum; *scm*, scutellum; *ptm*, postscutellum; *pt*, patagium, or shoulder tippet, covering the insertion of the wings. — *Original.*

FIG. 12. Side view of the thorax of *T. Polyphemus*, the hairs removed. 1, Prothorax; 2, Mesothorax; 3, Metathorax, separated by the wider black lines. Tergum of the prothorax not represented. *ms*, mesoscutum; *scm*, mesoscutellum; *ms''*, metascutum; *scm'''*, metascutellum; *pt*, a supplementary piece near the insertion of patagia; *w*, pieces situated at the insertion of the wings and surrounded by membrane; *em*, epimerum of prothorax, the long upright piece above being the episternum; *epm''*, episternum of the mesothorax; *em''*, epimerum of the same; *epm'''*, episternum of the metathorax; *em'''*, epimerum of the same, divided into two pieces; *c'*, *c''*, *c'''*, coxæ; *te'*, *le''*, *le'''*, trochantines; *tr*, *tr*, *tr*, trochanters. — *Original.*

Neuroptera, such as the *Polystœchotes* (Fig. 13 *a*), the præscutum is large, well developed, triangular, and wedged in between the two halves of the scutum. The little piece succeeding the scutellum, *i. e.* the postscutellum, is still smaller, and rarely used in descriptive entomology. Thus far we have spoken of the middle, or mesothoracic, ring, where these four pieces are most equally developed. In the first, or prothoracic, ring, one part, most probably the scutum, is well developed, while the others are aborted, and it is next to impossible to trace them in most insects. The prothorax in the higher insects, such as the Hymenoptera, Lepidoptera, and Diptera is very small, and often intimately soldered to the succeeding or meso-thoracic ring. In the lower insects, however, such as the Coleoptera, the bugs (Hemiptera), grasshoppers and their allies (Orthoptera), and the Neuroptera, the large broad prothorax consists almost entirely of this single piece, and most writers speak of this part under the name of "thorax," since the two posterior segments are concealed by the wings when the animal is at rest. The *metathorax* is usually very broad and short. Here we see the scutum split asunder, with the præscutum and scutellum wedged in between; while the postscutellum is aborted.

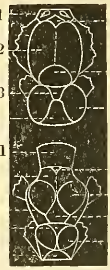


Fig. 13.

On the side are two pieces, the upper (epimerum) placed just beneath the tergum, which is the collective name for the four tergal, or dorsal, pieces enumerated above. In front of the epimerum and resting upon the sternum, as its name implies, is the *episternum*. These two parts (pleurites) compose the flanks of the elemental ring. To them the legs are articulated. Between the two episterna is situated the breast-piece (sternum), which shows a tendency to grow smaller as we ascend from the Neuroptera to the Bees.

In those insects provided with wings, the epimera are also subdivided. The smaller pieces, hinging upon each other, as it were, give play to the very numerous muscles of flight

FIG. 13. *a*, tergal view of thorax of *Hepialus* (*Sthenopis*); 1, prothorax; 2, mesothorax; 3, metathorax. The prothorax is very small compared with that of *Polystœchotes* (13 *a*, 1), where it is nearly as long as broad.— *Original.*

needed by the insect to perform its complicated motions while on the wing.

The insertion of the fore wing is concealed by the "shoulder tippets," or *patagia* (Fig. 11), which are only present in the mesothorax. The external opening of the spiracles just under the wing perforates a little piece called by Audouin the *peritreme*.

A glance at Figures 11 and 12 shows how compactly the various parts of the thorax are agglutinated into a globular mass, and that this is due to the diminished size of the first and third rings, while the middle ring is greatly enlarged to support the muscles of flight. There are four tergal, four pleural, two on each side (and these in the Hymenoptera, Lepidoptera, and Diptera subdivide into several pieces), and a single sternal piece, making nine for each ring and twenty-seven for the whole thorax, with eight accessory pieces (the three pairs of *peritremes* and the two *patagia*), making a total of thirty-five for the entire thorax; or, multiplying the four tergal pieces by two, since they are formed by the union of two primitive pieces on the median line of the body, we have thirty-nine pieces composing the thorax.

Table of the Parts of the Thorax applied to the Pro-, Meso-, and Metathorax, respectively.

Thorax	Dorsal Surface	Præscutum, Scutum, Scutellum, Postscutellum.
	Pleural Surface	Epimerum, Episternum, Episternal apophysis, Stigma, Peritreme.
	Sternal Surface	Sternum.

We must remember that these pieces are rarely of precisely the same form in any two species, and that they differ, often in a very marked way, in different genera of insects. How simple, then, is the typical ring, and how complex are the various subdivisions of that ring as seen in the actual, living insect, where each part has its appropriate muscles, nerves, and tracheæ!

We have seen how the thorax is formed in Insects generally, let us now advert to the two types of thorax in the six-footed

insects. In the higher series of suborders, comprising the Diptera, Lepidoptera and Hymenoptera, placing the highest last, the thorax shows a tendency to assume a globular shape; the upper side, or tergum, is much arched, the pleural region bulges out full and round, while the legs conceal at their insertion the sternum which is minute in size.

In the lower series, embracing the Coleoptera, Hemiptera, Orthoptera, and Neuroptera, the entire body tends to be more flattened; in the thorax the tergum is broad, especially that of the prothorax, while the pleurites (episterna and epimera) are short and bulge out less than in the higher series, and the sternum is almost invariably well developed, often presenting a large thick breast-plate bearing a stout spine or thick tubercle, as in *Œdipoda*. We can use these characters, in classifying insects into suborders, as they are common to the whole order. Hence the use of characters drawn from the wings and mouth-parts (which are sometimes wanting), leads to artificial distinctions, as they are *peripheral* organs, though often convenient in our first attempts at classifying and limiting natural groups.

The abdomen. In the hind body, or third region of the trunk, the three divisions of the typical ring (arthromere), are entire, the tergum is broad and often not much greater in extent than the sternum; and the pleurites also form either a single piece, or, divided into an epimerum and episternum, form a distinct lateral region, on which the stigmata are situated. The segments of the abdomen have received from Lacaze-Duthiers a still more special name, that of *urite*, and the different tergal pieces belonging to the several rings, but especially those that have been modified to form the genital armor have been designated by him as *tergites*. We have applied this last term to the tergal pieces generally. The typical number of abdominal segments is eleven. In the lowest insects, the Neuroptera, there are usually eleven; as we have counted them in the abdomen of the embryo of *Diplax*. In others, such as the Hymenoptera and Lepidoptera, there may never be more than ten, so far as present observation teaches us.

The formation of the sting, and of the male intromittent organ, may be observed in the full-grown larva and in the in-

complete pupa of the Humble-bee, and other thin-skinned Hymenopterous larvæ, and in a less satisfactory way in the young Dragon-flies.

If the larva of the Humble-bee be taken just after it has become full-fed, and as it is about to enter upon the pupa state, the elements (*sterno-rhabdites* Lacaze-Duthiers), or tubercles, destined to form the ovipositor, lie in separate pairs, in two groups, exposed distinctly to view, as in Figures 14–18. The ovipositor thus consists of three pairs of slender non-articulated tubercles, situated in juxtaposition on each side of the mesial line of the body. The first pair arises from the eighth abdominal ring, and the second and third pair grow out from the ninth ring. The ends of the first pair scarcely reach beyond the base of the third pair. With the growth of the semi-pupa, the end of the abdomen decreases in size, and is

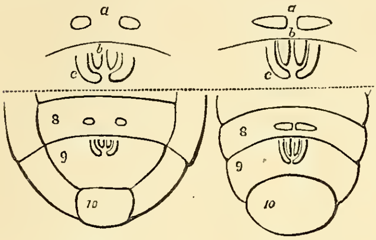


Fig. 14. Fig. 15.

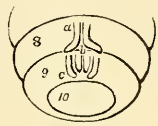
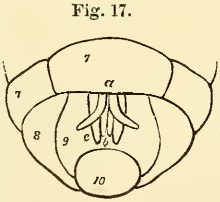
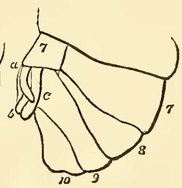
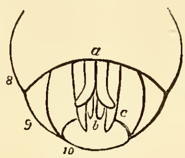


Fig. 16.

Fig. 17. 17*a*.







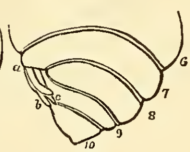


Fig. 18. 18*a*.

FIG. 14. Rudiments of the sting, or ovipositor, of the Humble-bee. 8, 9, 10, sternites of eighth, ninth, and tenth abdominal rings in the larva. *a*, first pair, situated on the eighth sternite; *b*, second and inner pair; and *c*, the outer pair. The lettering is the same in figures 14–22. The inner pair (*b*), forms the true ovipositor, through which the eggs are supposed to pass when laid by the insect, the two outer pairs, *a* and *c*, sheathing the inner pair.

FIG. 15. The same a little farther advanced.

FIG. 16. The same at a later stage, the three pairs approximating.

FIG. 17. The three pairs now appear as if together growing from the base of the ninth segment; 17*a*, side view of the same, showing the end of the abdomen growing smaller through the diminution in size of the under side of the body.

FIG. 18. The three pairs of rhabdites now nearly equal in size, and nearly ready to unite and form a tube; 18*a*, side view of the same; the end of the abdomen still more pointed; the ovipositor is situated between the seventh and tenth rings, and is partially retracted within the body.

gradually incurved toward the base (Fig. 18), and the three pairs of rhabdites approach each other so closely that the two outer ones completely ensheath the inner, until a complete extensible tube is formed, which is gradually withdrawn entirely within the body.

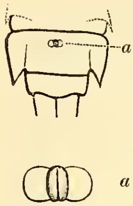


Fig. 19.

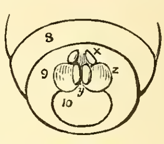


Fig. 20.

The male genital organ is originally composed of three pairs (two pairs, apparently, in *Æschna*, Fig. 19) of tubercles all arising from the *ninth* abdominal ring, being sternal outgrowths and placed on each side of the mesial line of the body, two being anterior, and very unequal in size, and the third pair nearer the base of the abdomen. The external genital organs cannot be considered as in any way homologous with the limbs, which are articulated outgrowths budding out between the sternal and pleural pieces of the *arthromere*.*

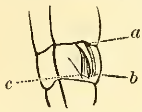


Fig. 21.

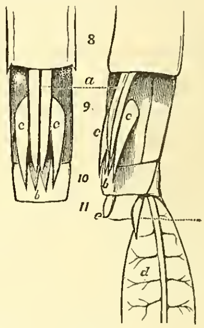


Fig. 22.

This view will apply to the genital armor of all Insects, so far as we have been able to observe. It is so in the pupa of *Æschna* (Fig. 21), and the pupa of *Agrion* (Fig. 22), which completely repeats, in its essential features, the structure of the ovipositor of *Bombus*. Thus in *Æschna* and *Agrion* the ovipositor consists of a pair of closely appressed ensiform processes which grow out from under the posterior edge of the eighth abdominal ring, and are embraced between two pairs

* This term is proposed as better defining the ideal ring, or primary zoölogical element of an articulated animal than the terms *somite* or *zoönite*, which seem too vague; we also propose the term *arthroderm* for the outer crust, or body walls, of Articulates, and *arthropleura* for the pleural, or limb-bearing region, of the body, being that portion of the arthromere situated between the tergite and sternite.

FIG. 19. The rudiments of the male intromittent organ of the pupa of Æschna, consisting of two flattened tubercles situated on the ninth ring; the outer pair large and rounded inclosing the smaller linear oval pair.

FIG. 20. The same in the Humble-bee, but consisting of three pairs of tubercles, *x*, *y*, *z*; 8, 9, 10, the last three segments of the abdomen.

FIG. 21. The rudimentary ovipositor of the pupa of *Æschna*, a Dragon-fly.

FIG. 22. The same in pupa of *Agrion*, a small Dragon-fly. Here the rudiments of the eleventh abdominal ring is seen. *d*, the base of one of the abdominal false gills.—*Figs.* 14–22 *original.*

of thin lamelliform pieces of similar form and structure, arising from the sternite of the ninth ring. These sternal outgrowths do not homologize with the filiform, antennæ-like, jointed appendages of the eleventh ring, as seen in the Perlidæ and most Neuroptera and Orthoptera (especially in *Mantis tessellata* where they (Fig. 23) closely resemble antennæ), which, arising as they do from the arthropleural, or limb-bearing region of the body, *i. e.* between the sternum and episternum, are strictly homologous with the abdominal legs of the Myriapoda, the "false legs" of caterpillars, and the abdominal legs of some Neuropterous larvæ (*Corydalis*, *Phyganeidæ*, *etc.*).

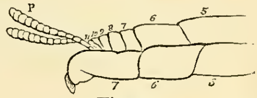


Fig. 23.

It will thus be seen that the attenuated form of the tip is produced by the decrease in size of certain parts, the actual disappearance of others, and the perfection of those parts to be of future use. Thus towards the extremity of the body the pleurites are absorbed and disappear, the tergites overlap on the sternites, and the latter diminish in size and are withdrawn within the body, while the last, or eleventh sternite, entirely disappears.* Meanwhile the sting grows larger and larger, until finally we have the neatly fashioned abdominal tip of the bee concealing the complex sting with its intricate system of visceral vessels and glands.

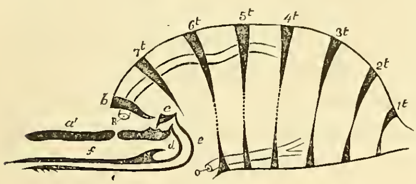


Fig. 24.

The ovipositor, or sting, of all insects, therefore, is formed on a common plan (Fig. 24). The solid elements of the arthro-

*In *Ranatra*, however, Lacaze-Duthiers has noticed the curious fact that in order to form the long respiratory tube of this insect, the tergite and sternite of the pregenital (eighth) segment are aborted, while the pleurites are enormously enlarged and elongated, so as to carry the stigmata far out to the end of the long tube thus formed.

FIG. 23. End of the abdomen of *Mantis tessellata*; *p*, many-jointed anal style resembling an antenna. 5–11, the seven last abdominal segments; the 8–11th sternites being obsolete.—*From Lacaze-Duthiers.*

FIG. 24. Ideal plan of the structure of the ovipositor in the adult insect. 1–7t, the tergites, connected by dotted lines with their corresponding sternites. *b*, the eighth tergite, or anal scale; *c*, epimerum; *a'*, *a*, two pieces forming the outer pair of rhabdites; *i*, the second pair, or stylets; and *f*, the inner pair, or sting; *d*, the

mere are modified to form the parts supporting the sting alone. The external opening of the oviduct is always situated between the eighth and ninth segments, while the anal opening lies at the end of the eleventh ring. So that there are really, as Lacaze-Duthiers observes, three segments interposed between the genital and anal openings.

The various modifications of the ovipositor and male organ will be noticed under the different suborders.

THE STRUCTURE OF THE HEAD. After studying the composition of the thorax and abdomen, where the constituent parts of the elemental ring occur in their greatest simplicity, we may attempt to unravel the intricate structure of the head. We are to determine whether it is composed of one, or more, segments, and if several, to ascertain how many, and then to learn what parts of the typical arthromere are most largely developed as compared with the development of similar parts in the thorax or abdomen. In this, perhaps the most difficult problem the entomologist has to deal with, the study of the head of the adult insect alone is only guesswork. We must trace its growth in the embryo. Though many writers consider the head as consisting of but a single segment, the most eminent entomologists have agreed that the head of insects is composed of two or more segments. Savigny led the way to these discoveries in transcendental entomology by stating that the appendages of the head are but modified limbs, and homologous with the legs. This view at once gave a clue to the complicated structure of the head. If the antennæ and biting organs are modified limbs, then there must be an elemental segment present in some form, however slightly developed in the mature insect, to which such limbs are attached. But the best observers have differed as to the supposed number of such theoretical segments. Burmeister believed that there were two only; Carus and Audouin thought there were three; McLeay and Newman four, and Straus-Durckheim recognized seven. From the study of the semipupa of the Humble-bee (*Bombus*)

support of the sting; *e*, the support of the stylet (*i*). *R*, the anus; *O*, the outlet of the oviduct. The seventh, eighth, and ninth sternites are aborted.—*From Lacaze-Duthiers.*

and several low Neuropterous forms, as the larva of *Ephemera*, but chiefly the embryo of *Diplax*, a dragon-fly, we have concluded that there are seven such elemental segments in the head of insects.

That there are four corresponding to the jointed appendages, *i. e.* the labium, or second maxillæ, the first maxillæ, the mandibles, and the antennæ, seems indisputable. But where else are we to look for jointed appendages in an insect's head? We must go out of the class of Insects and study the stalk-eyed Crustacea, such as the Lobster, where the eye is supported on a two-jointed stalk, which has been homologized with the limbs. While, therefore, the eyes of insects are never "stalked," as in the Lobster and Shrimp, they are evidently developed, as in the Crustacean, upon a separate segment (or its rudiments), which may be called the "ophthalmic ring," and which is, therefore, the fifth cephalic ring. In advance of the eyes are normally placed the three ocelli, though in the highest Insects (the Diptera, Lepidoptera, and Hymenoptera) they appear to be situated in the rear of the eyes.

Each of these three ocelli is situated upon a distinct piece; but we must consider the anterior single ocellus as in reality formed of two, since in the immature pupa of Bombus the anterior ocellus is differently shaped from the two posterior ones, being transversely ovate, resulting, as I think, from the fusion of two originally distinct ocelli, and not round like the other two. There are, therefore, two pairs of ocelli, and hence they grow from the rudiments of a sixth and seventh ring respectively.

Now, since the *arthropleural* is the limb-bearing region in the thorax, it must follow that this region is largely developed in the head, to the bulk of which the sensory and digestive organs bear so large a proportion; and as all the parts of the head are subordinated in their development to that of the appendages of which they form the support, it must follow logically that the larger portion of the body of the head is *pleural*, and that the *tergal*, and especially the *sternal*, parts are either very slightly developed, or wholly obsolete. Thus each region of the body is characterized by the relative development of the three parts of the arthromere. In the abdomen the upper

(tergal) and under (sternal) surfaces are most equally developed, while the pleural line is reduced to a minimum. In the thorax the pleural region is much more developed, either quite as much, or often more than the upper, or tergal portion, while the sternal is reduced to a minimum. In the head the pleurites form the main bulk of the region, the sternites are reduced to a minimum, and the tergites may be identified in the occiput, the clypeus, and labrum.

TABLE OF THE SEGMENTS OF THE HEAD AND THEIR APPENDAGES, BEGINNING WITH THE MOST ANTERIOR.*

	Preoral.	
(*Hypothetical*),	Tergal,	Labrum, epipharynx, clypeus.
First Segment (*First Ocellary*),	Pleural,	Anterior ocellus (originally double).
Second Segment (*Second Ocellary*),	Pleural,	Two posterior ocelli.
Third Segment (*Ophthalmic*),	Pleural,	Eyes.
Fourth Segment (*Antennary*),	Pleural,	Antennæ.
	Postoral.	
Fifth Segment (*Mandibular*),	Pleural,	Mandibles.
Sixth Segment (*First Maxillary*),	Pleural,	First maxillæ.
Seventh Segment (*Second Maxillary, or Labial*),	Tergal (occiput), Pleural (gena), Sternal (gula),	Second maxillæ (Labium).

The Appendages. We naturally begin with the thoracic appendages, or *legs*, of which there is a pair to each ring. The leg (Fig. 25) consists of seven joints, the basal one, the *coxa*, in the Hymenoptera, Lepidoptera, and Diptera, consisting of two

* In the first column are enumerated the seven rings, or segments, composing the head. The tergal parts (*i.e.* the labrum, epipharynx, and clypeus), situated in front of the ocelli, are left out in enumerating the seven segments, as they are not supposed by the author to belong to either of those segments.

In the first column the seven rings are named (in brackets) according to the sort of appendages they bear. In the second column is given the part, or parts, of the ideal segment supposed actually to exist in an insect's head; and in the third column are to be found the names of the organs attached to their corresponding segments, beginning with the front and going back to the base of the head.

pieces, *i. e.* the coxa and *trochantine* (see Fig. 12); the *trochanter;* the *femur;* the *tibia*, and, lastly, the *tarsus*, which is subdivided into from one to five joints, the latter being the normal number. The terminal joint ends in a pair of claws between which is a cushion-like sucker called the *pulvillus.* This sucking disk enables the Fly to walk upside down and on glass.

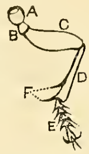


Fig. 25.

In the larva, the feet are short and horny, and the joints can be still distinguished. In Myriapods, each segment of the abdomen has a pair of feet like the thoracic ones. We must consider the three pairs of spinnerets of Spiders, which are one to three-jointed, as homologous with the jointed limbs of the higher insects. In the six-footed insects (Hexapoda), the abdominal legs are deciduous, being present in the Coleopterous grub, the Dipterous maggot, the caterpillar, and larva of the Saw-fly, but disappearing in the pupa state. They are often, as in most maggots, either absent, or reduced in number to the two anal, or terminal, pair of legs; while in the Saw-flies, there are as many as eight pairs. These "false" or "prop-legs" are soft and fleshy, and without articulations. At the retractile extremity is a crown of hooks, as seen in caterpillars or the hind-legs of the larva of *Chironomus* (Fig. 26), in which the prothoracic pair of legs is reduced to inarticulate fleshy legs like the abdominal ones.

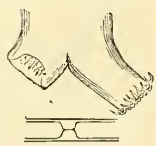


Fig. 26.

The *position* of the different pairs of legs deserves notice in connection with the principle of "antero-posterior symmetry." The fore-legs are directed forwards like the human arms, but the two hinder pairs are directed backwards. In the Spiders, three pairs of abdominal legs (spinnerets) are retained throughout life; in the lower Hexapods, a single pair, which is appended to the eleventh segment, is often retained, but under a form which is rather like an antenna, than limb-like. In some Neuropterous larvæ (*Phryganea*, *Corydalus*, etc.) the anal pair of limbs are very well marked; they constitute the "anal forceps" of the adult insect. They sometimes become true, many-jointed appendages, and are then remarkably like

FIG. 25. A, coxa; B, trochanter; C, femur; D, tibia; F, tibial spurs; E, tarsus, divided into five tarsal joints, the fifth ending in a claw.—*From Sanborn.*

antennæ, as in the instance of *Mantis tessellata* described by Lacaze-Duthiers (Fig. 23). In the Cockroach these appendages, sometimes called "anal cerci," resemble the antennæ of the same insect. In the Lepidoptera and Hymenoptera they do not appear to be jointed, and are greatly aborted.

The Wings. The wings of insects first appear as little soft vascular sacs permeated by tracheæ. They grow out in the preparatory stages (Fig. 27) of the pupa from the side of the thorax and above the insertion of the legs, *i.e.* between the epimerum and tergum. During the pupa state they are pad-like, but when the pupa skin is thrown off they expand with air, and in a few minutes, as in the Butterfly, enlarge to many times their original size. The wings of insects, then, are simple expansions of the crust, spread over a framework of horny tubes. These tubes are really double, consisting of a central trachea, or air tube, inclosed within a larger tube filled with blood, and which performs the functions of the veins. Hence the aeration of the blood is carried on in the wings, and thus they serve the double purpose of lungs and organs of flight.

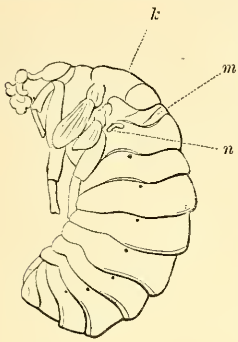


Fig. 27.

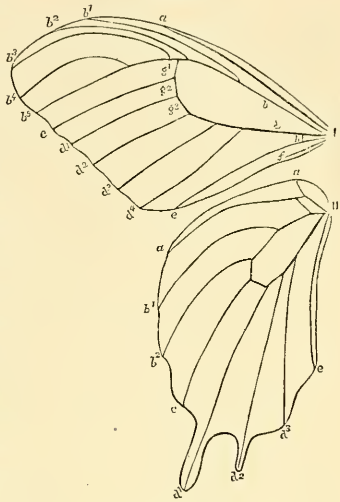
The number and situation of these veins and their branches (veinlets) are of great use in separating genera and species. The typical number of primary veins is five. They diverge outward at a slight angle from the insertion of the wing, and are soon divided into veinlets, from which cross veins are thrown out connecting with others to form a net-work of veins and veinlets, called the *venation* of the wing (Figs. 28, 29). The interspaces between the veins and veinlets are called *cells*.

At a casual glance the venation seems very irregular, but in many insects is simple enough to enable us to trace and name the veinlets. The five main veins, most usually present, are

FIG. 27. The semipupa of *Bombus*, the larva skin having been removed, showing the two pairs of rudimentary wings growing out from the mesothorax (k), and metathorax (m). n and the seven succeeding dots represent the eight abdominal stigmata, the first one (n) being in the pupa situated on the thorax, since the first ring of the abdomen is in this stage joined to the thorax. — *Original.*

called, going from the *costa*, or front edge, the *costal*, *subcostal*, *median*, *submedian*, and *internal*, and sometimes the median divides into two, making six veins. The costal vein is undivided; the subcostal and median are divided into several branches, while the submedian and internal are usually simple.

Fig. 28.



The venation of the fore-wings affords excellent marks in separating genera, but that of the hind wings varies less, and is consequently of less use.

The wings of many insects are divided by the veins into three well-marked areas; the *costal*, *median*, and *internal*. The costal area (Fig. 31 *b*) forms the front edge of the wing and is the strongest, since the veins are nearer together than elsewhere, and thus afford the greatest resistance to the air

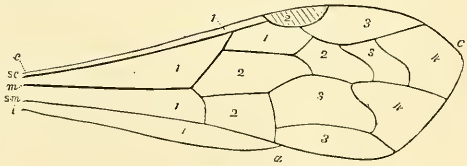


Fig. 29.

Fig. 28. Fore and hind wings of a Butterfly, showing the venation. I. fore wing: *a*, costal vein; *b*, subcostal vein; b^1, b^2, b^3, b^4, b^5, five subcostal veinlets; *c*, independent vein (it is sometimes a branch of the subcostal, and sometimes of the median vein); *d*, median vein; d^1, d^2, d^3, d^4, four median veinlets; *e*, submedian vein; *f*, internal vein; *h*, interno-median veinlet (rarely found, according to Doubleday, except in Papilio and Morpho); *b* and *d* are situated in the "discal cell;" g^1, g^2, g^3, the upper, middle, and lower discal veinlets. In the Bombycidæ and many other moths g^1 and g^2 are thrown off from the subcostal and median veins respectively, meeting in the middle of the cell at g^2. They are sometimes wholly absent.

II. The hind wing; the lettering and names of the veins and veinlets the same as in the fore wing.—*Slightly changed from Doubleday.*

Fig. 29. Fore wing of a Hymenopterous insect. *c*, costal vein; *sc*, subcostal vein; *m*, median vein; *sm*, submedian vein; *i*, internal vein; *c*, 1, 2, 3, the first, second, and third costal cells; the second frequently opaque and then called the *pterostigma*. *sc*, 1, 2, 3, 4, the four subcostal cells; *m*, 1, 2, 3, 4, the median cells; *sm*, 1, 2, 3, the three submedian cells; i^1, the internal cell; this is sometimes divided into two cells, and the numbers of all but the costal cells is inconstant, the outer row of cells (4, 4, 3) being the first to disappear.

The *costal edge* extends from *c* to *c*; the outer *c*, the *apex*; the *outer edge* extends from the apex (*c*) to *a*, and the *inner edge* extends from *a*, the inner angle, to the insertion of the wing at *i*.—*Original.* Figs. 30–32 *from Scudder*.

during flight. The median area (Fig. 31 *a*) is the largest. It is in the grasshoppers and crickets sometimes modified to form a musical organ, being drum-like, as in the *Œcanthus* (Fig. 30), or rasp-like, as in *Archyptera* (Fig. 31 *a*). The internal area (*c*) is the smallest, and less distinctly marked than the two other regions; the musical file-like organ of *Orchelimum vulgare*, a common grasshopper (Fig. 32 *d*) is situated on this area.

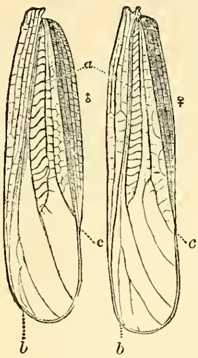


Fig. 31.

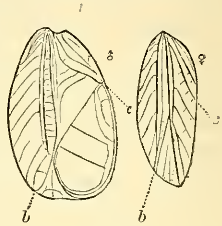


Fig. 30.

The limits of the edges of the wing vary in almost every genus, and their comparative length afford excellent generic characters. The front edge (Fig. 29) is called the *costal*, its termination in the outer angle of the wing is called the *apex;* the *outer edge* is situated between the apex and the *inner angle*, between which and the base of the wing is the inner, or *internal*, edge. These distinctions are of most use in describing the butterflies and moths.

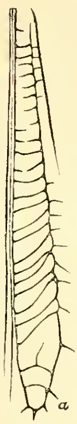


Fig. 31 *a*.

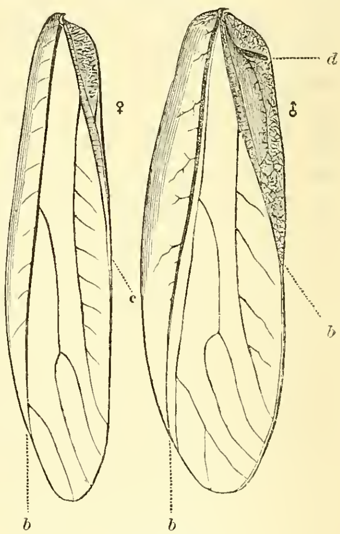


Fig. 32.

The Appendages of the Head. These organs are divided into two groups, the first of which comprise the sensory organs, *i. e.* the ocelli, eyes, and antennæ, which are attached to the region in front of the mouth, or *preoral* region of the head. The second group consists of the sensorio-digestive appendages, combining the power of finding and seizing the food and preparing it for digestion. They are inserted behind the mouth and belong to the *postoral* region of the head.

We will first describe the ocelli, going backwards to the basal appendages, the labium (second maxillæ) being the hindermost.

The simple eye, *Ocellus*, or *Stemma*, is the simplest form of the eye. Its most elementary form (seen in the larva of the Bot-fly and the Cecidomyian larva of *Miastor*) is that of a brown spot, or group of pigment-cells lodged under the skin and against which a nerve-filament impinges. Over this spot Newport states that the tegument is transparent and convex, resembling a true cornea, or eye-lens. A well-developed ocellus consists, according to Newport, of a "very convex, smooth, single cornea, beneath which is a spherical crystalline lens, resting upon the plano-convex surface of the expanded vitreous humor, the analogue of the transparent cones of the compound eyes." Müller believes that the function of the ocelli is the perception of nearer objects, while that of the compound eyes is to see more distant objects. The ocelli constitute the only visual organs in the Myriapods (except *Cermatia*), the Arachnida, and the larvæ of many Six-footed Insects; they are usually from one to six on a side. In adult insects they are generally three in number, and are generally present except in the large majority of Coleoptera. Their *normal* site is in front of the eyes, but they are usually thrown back, during the growth of the insect, behind the eyes, on the vertex, or topmost part of the head (Fig. 33).

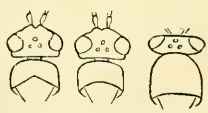


Fig. 33.

The Compound Eyes are a congeries of simple eyes. During the growth of the insect the simple eyes of the larva increase in number, and finally coalesce to form the compound eye, or compound cornea, the surface of which is very convex and protuberant in the predaceous insects, or those requiring an extended field of vision.

Fig. 34.

The number of facets, or corneæ, vary from fifty (in the Ant) to 3,650, the latter number being counted by Geoffroy in the eye of a Butterfly. These facets are usually hexagonal, as in the Dragon-fly (Fig. 34), or, rarely, quadrangular.

FIG. 33. Ocelli of three species of Sand-wasps, *Pompilus*.—*From Cresson.*

FIG. 34. Three hexagonal facets of the compound eye of a fossil Dragon-fly, greatly magnified.—*From Dawson.*

3

The *Antennæ* (Figs. 35, 36) are inserted usually in the adult insect between, or in front of the eyes, though normally the antennary is posterior to the ophthalmic ring. It is normally a long, filiform, slender, many-jointed appendage, undergoing great changes in form. When it is highly specialized, as in Coleoptera and Hymenoptera, it is divided into three parts, the basal or *scape*, the middle or *pedicel*, and the terminal part or *flagellum*, or *clavola*, which usually comprises the greater part of the antenna.

Fig. 35.

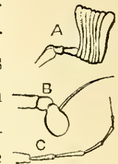


Fig. 36.

It is believed by some that the sense of hearing is lodged in the antennæ, though Siebold has discovered an auditory apparatus situated at the base of the abdomen of some, and in the fore-legs of other species of Grasshoppers.

Mr. J. B. Hicks has made the latest studies on the auditory apparatus. According to him "it consists first of a cell, sac, or cavity filled with fluid, closed in from the air by a membrane analogous to that which closes the *foramen ovale* in the higher animals; second, that this membrane is, for the most part, thin and delicate, but often projects above the surface, in either a hemispherical, conical, or canoe-shaped, or even hair-like form, or variously marked; thirdly, that the antennal nerve gives off branches which come in contact with the inner wall of the sacs; but whether the nerve enters, or, as is most probable, ends in the small internally projecting papilla which I have shown to exist in many of these sacs, it is very difficult to say. The principal part of the nerve proceeds to these organs, the remaining portion passing to the muscles, and to the roots of the hairs, at least to those of the larger sort." On the other hand, Lefebvre, Leydig, and Gerstaecker regard this so-called "auditory apparatus" as an organ of smell.

The antennæ have also the sense of touch, as may readily be observed in Ants, Bees, and the Grasshopper and Cockroach. "The Honey-bee, when constructing its cells, ascertains their proper direction and size by means of the extremities of these

FIG. 35. Filiform antenna of *Amphizoa*.—*From Horn.*

FIG. 36. A, lamellate antenna of a Lamellicorn Beetle; B, antenna of a Fly, with the bristle thrown off from the terminal joint; C, bristle-like antenna of a Dragon-fly, *Libellula*.—*From Sanborn.*

organs; while the same insect, when evidently affected by sounds, keeps them motionless in one direction, as if in the act of listening." (Newport.)

After cutting off one or both antennæ of the June beetle, *Lachnosterna*, the insect loses its power of directing its flight or steps, wheeling about in a senseless manner. Dr. Clemens observed that the Cecropia moth was similarly affected after losing its antennæ.

The Mandibles (Fig. 37) are inserted on each side of the mouth-opening. They usually consist of but a single joint,

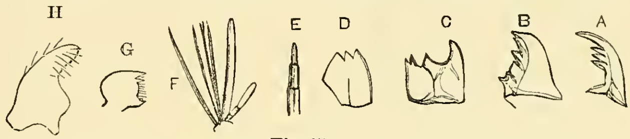


Fig. 37.

representing probably the basal part of the ideal limb. This part, however, is often subdivided by two longitudinal furrows into three parts, each ending in a "tooth" of unequal size for tearing and cutting the food. This tripartite form of the mandibles, to which attention has been called by Mr. Scudder, is more fully carried out in the maxilla, where each portion is highly specialized. The mandibles vary greatly in form and size. The two cutting edges are usually opposed to each other, or frequently overlap in the carnivorous forms. Their base is often concealed by the clypeus and labrum. Their motion is transverse, being the reverse of the motion of the jaws of Vertebrates.

a Fig. 38. *b*

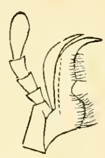


Fig. 39.

The Maxillæ (Figs. 38 *b*, 39) are much more complicated organs than the mandibles. They are

FIG. 37. Different forms of mandibles. A, mandible of *Cicindela purpurea*; B, *Phylloptera*, a green grasshopper; C, *Libellula trimaculata*; D, *Vespa maculata*, or paper-making Wasp; E, "rostrum" or jointed sucker of the Bed-bug, *Cimex lectularius*, consisting of mandibles, maxillæ, and labium; F, proboscis, or sucker, of a Mosquito, *Culex*, in which the mandibles are long and bristle-like.—*From Sanborn.* G, mandible of *Amphizoa*; H, mandible of *Acratus*, a genus of Cockchafers.—*From Horn.*

FIG. 38. *a*, mentum and labial palpi; *b*, one maxilla, with its palpus, of *Acratus*.—*From Horn.*

FIG. 39. Maxilla of *Amphizoa*, with the two lobes (stipes and lacinia), and the palpifer bearing the four-jointed palpus.—*From Horn.*

inserted on the under side of the head and just behind the mouth. The maxilla consists of a basal joint, or *cardo*, beyond which it is subdivided into three lobes, the *stipes*, or footstalk; the *palpifer*, or palpus-bearer; and the *lacinia*, or blade. The stipes forms the outer and main division of the organ. The lacinia is more membranaceous than the other parts, and its upper surface is covered with fine hairs, and forms a great part of the side of the mouth. It is divided into two lobes, the superior of which is called the *galea*, or helmet, which is often a thick double-jointed organ edged with stiff hairs, and is used as a palpus in the Orthoptera and many Coleoptera. The inferior lobe is attached to the internal angle of the lacinia. It terminates in a stiff minute claw, and is densely covered with stout hairs. The *maxillary palpi* are long, slender, one to four-jointed organs, very flexible and sensitive.

The maxillæ vary greatly in the different groups. Their office is to seize the food and retain it within the mouth, and also to aid the mandibles in comminuting it before it is swallowed. This function reminds us of that of the tongue of vertebrate animals.

The *labium*, or *second maxillæ* (Fig. 40), is placed in front of the *gula*, which forms the under part of the head, and is bounded on each side by the *genæ*, or cheeks, and posteriorly by the occiput. The genæ are bounded laterally by the epicranium and the under side of the eyes. In front are situated the basal parts of the labium, or second maxillæ, which embraces the *submentum* and *mentum* (or labium proper). The labial palpi are inserted into the mentum, but often the latter piece is differentiated into two, the anterior of which takes the name of *palpiger*, called by Dr. Leconte (Smithsonian Miscellaneous Collections) the ligula, and the palpi originate from them. The *ligula* is the front edge of the labium, being the piece forming the under lip. It is often a fleshy organ, its inner surface being continuous

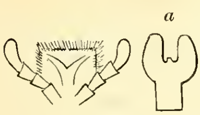


Fig. 40.

FIG. 40. Ligula and labial palpi of *Amphizoa*, an aquatic beetle. It is quadrate and without paraglossæ; *a*, mentum of the same, being deeply incised, and with a tooth at the bottom of the excavation. — *From Horn.*

with the soft membrane of the mouth. In the Bees, it is enormously developed and covered with soft hairs. It is often confounded with the palpiger. In *Hydrous* it is divided into two lobes. In most of the *Carabidæ* and Bees it is divided into three lobes, the two outer ones forming the *paraglossæ* (Fig. 41 *m*), and acting as feelers, while the middle, usually much longer, forms the *lingua*, or tongue, being the continuation of the ligula. In the bees, where the ligula is greatly developed, it performs the part of the tongue in Vertebrates, and aids the maxillæ in collecting nectar and pollen.

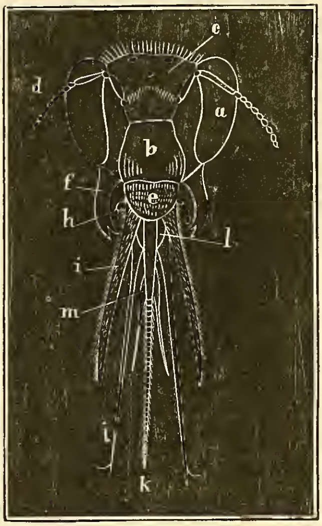


Fig. 41.

The roof of the mouth is formed by the *labrum* and the *epipharynx* (Fig. 42 *c*), a small fleshy tubercle concealed beneath the labrum. It is seen in the bees on turning up the labrum. It probably corresponds to the "labellum" of Schiödte. The labrum (Fig. 41 *e*) is usually transverse and situated in front of the *clypeus* (Fig. 41 *b*). The shield-like *clypeus* is the broad, visor-like, square piece forming usually the front of the head. Behind it is the *clypeus posterior*, or *supra-clypeus*, a subdivision of the clypeus, and especially observable in the Hymenoptera. The *epicranium* forms a large part of the head; it is bounded posteriorly by the *occiput*, on the sides by the eyes, and in front by the clypeus, and though usually described as a single piece, is really composed of several. The ocelli often appear to be situated upon it, though in reality they are placed upon a distinct piece or pieces. The "epicranial suture" is the line of junction of the two "procephalic lobes" (Huxley).

Fig. 41. Front view of the head of a bee, *Anthophora*. *a*, compound eyes; *c*, three simple eyes, situated upon the epicranium; *b*, clypeus; *e*, labrum; *d*, antennæ; *f*, mandibles; *i*, maxillæ; *h*, maxillary palpi; *l*, palpifer; *j*, labial palpi; *m*, paraglossæ; *k*, ligula.—*From Newport.*

(These lobes will be explained farther on when speaking of their development in the embryo.) Behind the epicranium is the *occiput*, or base of the head. It belongs to the labial, or second maxillary segment, and helps to form a complete ring, articulating with the thorax. It is perforated by a foramen to afford a connection between the interior of the head and thorax. It is sometimes, as in many Coleoptera, Orthoptera, and Hemiptera, elongated behind and constricted, thus forming a "neck." It will be seen beyond, that the labrum and clypeus are in the embryo developed from a "tongue-like process whose inferior part eventually becomes the labrum, while superiorly it sends a triangular process (the rudiment of the clypeus) into the interval between the procephalic lobes."* This part (*i.e.* the clypeus and labrum) is the most anterior part of the head, and in the embryo, as in the adult, is normally situated in front of the ocelli, and may be compared with the "anal plate," or eleventh tergite, of the larva.†

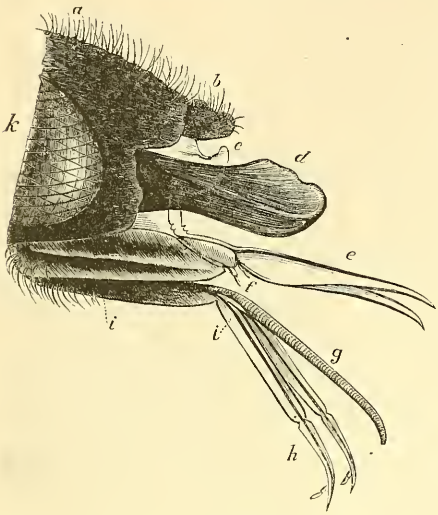


Fig. 42.

FIG. 42. Side view of the front part of the head, together with the mouth-parts of the Humble-bee (Bombus). *a*, clypeus covered with hairs; *b*, labrum; *c*, the fleshy epipharynx partially concealed by the base of the mandibles (*d*); *e*, lacinia, or blade of the maxillæ, with their two-jointed palpi (*f*) at the base; *j*, the labium to which is appended the ligula (*g*); below are the labial palpi; *h*, the two basal joints, being greatly enlarged; *k*, the compound eyes.—*Original.*

* These lobes are folded back upon the top of the base of the head, and they seem to form the *tergal* portion of the hypothetical, elemental ring, or rings, to which they respectively belong, and do not seem to us to be the *sternal* portion, as suggested by Huxley, for they are apparently developed in front of the mouth-opening, and form the roof of the mouth.

† "Lastly, there are certain parts developed singly in the median line in the *Articulata.* Of this nature are the frontal spines of *Crustacea*, their telson, and the sting

In describing Insects the *vertex*, or crown, of the head is the highest part; and the *front* is the part usually in front of the insertion of the antennæ.

The Muscular System lies just beneath, and is continuous with the integument. It consists of numerous "distinct isolated straight fibres, which are not gathered into bundles united by common tendons, or covered by aponeuroses [or tendinous sheaths] to form distinct muscles, as in the Vertebrata, but remain separate from each other, and only in some instances are united at one extremity by tendons." (Newport.) These minute fibres form layers, which Newport regards as separate muscles. "Each fibre is composed of a great number of very minute fibrillæ, or fasciculi of fibrillæ," and has been observed by Wagner and Newport to be often striated as in Vertebrates. The muscular system is simplest in the lower insects and the larvæ of the higher forms, and is more complex in the head than elsewhere, and more complex in the thorax than in the abdomen. These minute muscles are excessively numerous. "Lyonnet, in his immortal work on the anatomy of the larva of *Cossus ligniperda*, found two hundred and twenty-eight distinct muscles in the head alone, and, by enumerating the fibres in the layers of the different segments, reckoned 1,647 for the body, and 2,118 for the internal organs, thus making together 3,993 muscles in a single larva. In the larva of *Sphinx ligustri* we have found the muscles equally numerous with those discovered by Lyonnet in the Cossus." (Newport.)

The muscular system corresponds to the jointed structure of insects, as do the other internal systems of organs. Of the muscles belonging to a single ring, some stretch from the front edge of one segment to the front edge of the next, and others

of the Scorpion, whose mode of development appears to be precisely similar to that of a telson. In the same category we must rank the labrum in front of the mouth, which in the *Crustacea* (at least) appears to be developed from the sternum of the antennary, or third somite, the metastoma (or so called labium, or lingua) of *Crustacea*, and the lingua of *Insecta*, behind the oral aperture.

"However much these appendages may occasionally simulate, or play the part of appendages, it is important to remember, that, morphologically, they are of a very different nature, and that the confusing them with true appendages must tend completely to obscure the beautiful relations which obtain among the different classes of the *Articulata*."—*Huxley*, Linnæan Transactions, vol. xxii. London.

to the hinder edge; there are also sets of dorsal and ventral muscles going in an oblique or vertical course. The muscles are either colorless and transparent, or yellowish white and of a soft, almost gelatinous consistence. In form they are simply flat and thin, straight, band-like, or pyramidal, barrel or feather-shaped. They act variously as *rotators*, *elevators*, *depressors*, *retractors*, *protrusors*, *flexors*, and *extensors*.

The *muscular power* of insects is enormous. The Flea will leap two hundred times its own height. Certain beetles can support enormous weights. Newport cites the case of *Geotrupes stercorarius* which is "able to sustain and escape from beneath a pressure of from twenty to thirty ounces, a prodigious weight when it is remembered that the insect itself does not weigh even so many grains." Some beetles have been known to gnaw through lead-pipes, and the Stag-beetle of Europe, *Lucanus cervus*, has, as stated by Mr. Stephens, gnawed "a hole an inch in diameter through the side of an iron canister in which it was confined."

"The *motions* of the insect in walking as in flying are dependent, in the perfect individual, entirely upon the thoracic segments, but in the larva chiefly upon the abdominal. Although the number of legs in the former is always six, and in the latter sometimes so many as twenty-two, progression is simple and easy. Müller states (Elements of Physiology, p. 970, Translation) that on watching insects that move slowly he has distinctly perceived that three legs are always moved at one time, being advanced and put to the ground while the other three propel the body forwards. In perfect insects, those moved simultaneously are the fore and hind feet on one side, and the intermediate foot on the opposite; and afterwards the fore and hind feet on that side, and the middle one on the other, so that, he remarks, in two steps the whole of the legs are in motion. A similar uniformity of motion takes place in the larva, although the whole anterior part of the body is elevated and carried forwards at regular distances, the steps of the insect being almost entirely performed by the 'false,' or abdominal legs."

"In *flight* the motions depend upon the meso- and metathoracic segments conjointly, or entirely upon the former. The

sternal, episternal, and epimeral pieces, freely articulated together, correspond in function with the sternum, the ribs, and the clavicles of birds.* The thorax is expanded and contracted at each motion of the wings, as in birds and other animals, and becomes fixed at each increased effort as a fulcrum or point of resistance upon which the great muscles of the wings are to act, thus identifying this part of the body in function as in structure with that of other animals." (Newport.)

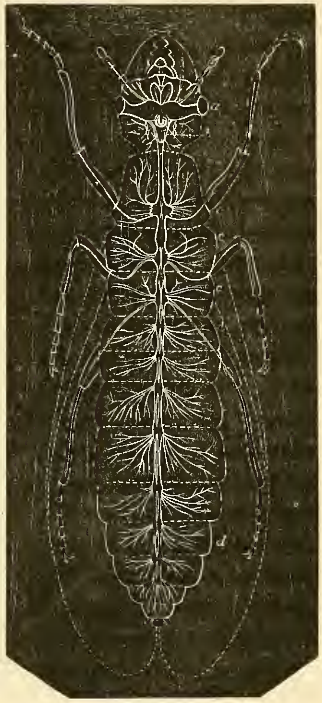


Fig. 43.

THE NERVOUS SYSTEM. In its simplest form the nervous system consists of two longitudinal cords, each with a swelling (nerve-knot, or ganglion,) corresponding to each segment (Fig. 43). This cord lies on the ventral side of the body, but in the head it passes upwards, sending a filament from each side to surround the œsophagus.† As in the Vertebrates, the nervous cord of insects is composed of two distinct columns of fibres placed one upon the other. "The under or *external* column, which is nearest to the exterior of the body, is that in which the ganglia, or enlargements, are situated. The upper one, or that which is *internal* and nearest to the viscera, is entirely without ganglia, and passes directly over the ganglia of the under column without forming part of them, but in very

* Bennet on the Anatomy of the Thorax in Insects, and its Function during Flight. Zoölogical Journal, vol. i, p. 394.

† The brain of insects is formed of several pairs of ganglia, corresponding, probably, to the number of primitive segments composing the head. The nervous cord is thus, in the head, massed together and compacted to form a brain.

FIG. 43. Nervous System of *Corydalus cornutus*. *a*, "cerebrum;" *b*, "cerebrellum;" *c*, thoracic ganglia, which distribute a nerve to each leg; *d*, eight pairs of abdominal ganglia. The dotted lines represent the wings.—*From Leidy*.

close approximation to them." Newport also believes that the ganglionless upper, or internal, column of fibres is analogous to the *motor* column of Vertebrata, while the external, or under one, corresponds to the *sensitive* column, thus representing the cerebro-spinal system of the Vertebrata.

From each pair of ganglia are distributed special nerves to the various organs. In the larva of *Sphinx* the normal number of double ganglia is thirteen, and the nervous cord of the Neuroptera and other lowly organized and attenuated forms of insects corresponds in the main to this number. In the adult insect, especially in the Coleoptera, Diptera, Lepidoptera, and Hymenoptera, the three thoracic ganglia are fused together, following the fusion and general headwise development of the segments of the tegument. Besides the central nervous cord, corresponding to the spinal cord of the Vertebrates, there is a *vagus*, or *visceral nerve*, representing the sympathetic nerve of higher animals. This nerve "arises, in the larva, from the anterior part of the cerebrum, and, forming a ganglion on the upper surface of the pharynx, always passes backward beneath the brain, along the middle line of the œsophagus." In its microscopic structure the nervous cord, like that of Vertebrata, consists of a central "white" substance, and an outer or peripheral part, the "gray" substance.

In the embryo the ganglia are very large and close together, the commissures, or connecting filaments being very short, and small in proportion.

Organs of Nutrition. These consist of the alimentary canal and its appendages, or accessory glands (Fig. 44). We have already treated of the external appendages (mouth-parts) which prepare the food for digestion. The simplest form of the alimentary canal is that of a straight tube. In the larva of *Stylops*, and the sedentary young of Bees it ends in a blind sac, as they live on liquid food and expel no solid excretions. When well developed, as in the adult insect, it becomes a long convoluted thick muscular tube, subdivided into different parts which perform different functions and have distinct names, taken from analogous organs in the vertebrate animals. This digestive tube is composed of three coats, the outer, or *peri-*

toneal; the middle, or *muscular;* and the inner, or *mucous.* The mucous coat is variously modified, being plaited or folded; or,

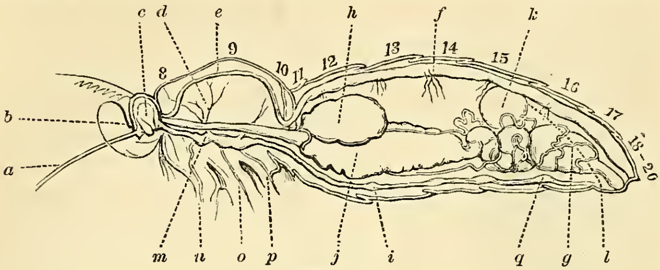


Fig. 44.

as in the Orthoptera and carnivorous Coleoptera, it is solidified and covered with rows of strong horny teeth, forming a sort of gizzard. The alimentary canal is held in place by retractor muscles, but principally by exceedingly numerous branches of the main tracheæ.

This canal (Fig. 45) is subdivided into the *mouth* and *pharynx*, the *œsophagus*, supplementary to which is the *crop*, or "sucking stomach" of Diptera, Lepidoptera, and Hymenoptera. The *proventriculus*, or gizzard; the *ventriculus*, or true stomach succeed, and the intestine consists of the *ileum*, or short intes-

Fig. 44. Anatomy of *Sphinx ligustri.* *m*, *i*, *q*, the nervous cord resting on the floor of the body; at *c*, the ganglia form a brain-like organ, much larger than the ganglia of the thorax (*m*) and abdomen (*q*). From the brain is sent off the subœsophageal nerve which surrounds the gullet into which the food is conveyed by the maxillæ, or spiral tongue (*a*), which, when at rest, is rolled up between the labial palpi (*b*).

From the nervous cord is also thrown off a pair of nerves to each pair of legs (as at *n*, *o*, *p*) and a branch, *d*, is sent off from above, distributing nerves to the muscles of flight.

The heart, or dorsal vessel (*e*, *f*), lies just beneath the median line of the body, and is retained in place by muscular bands (as at *f*) as well as by small tracheal branches.

The alimentary canal (*h*, *j*, *g*), forms a straight tube in the head and thorax; *h*, the crop, or sucking stomach, which opens into the œsophagus; *j*, the true, chyle-forming stomach, which contracts posteriorly, and then dilates near its anal outlet into a *cloaca* (indicated at *g*, but not distinctly, as it is concealed by the numerous urinary vessels). The urinary vessels also indicated at *g*, form long tubes (which correspond to the kidneys of Vertebrates), opening into the pyloric end of the stomach. The position of the testes (*k*) is the same as that of the ovary, and the dotted line *l* shows the course of the efferent duct (*vas deferens*) and also of the oviduct of the female.

The numerals indicate the number of segments of the body, which in the Lepidoptera, consists of twenty, the 21st, or 11th abdominal, being absent.—*From Newport.*

tine, and the *colon* and *rectum*. The latter part, as well as the crop and proventriculus, is sometimes absent.

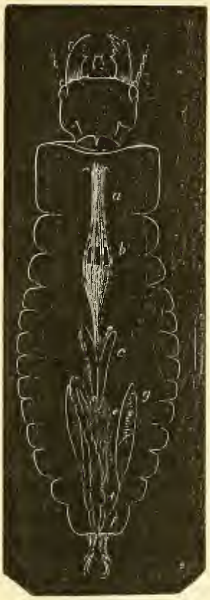


Fig. 45.

Of the *appendages of the canal*, the first are the *salivary glands*, which are usually long simple tubes, which in the larva, according to Newport, form the *silk vessels*. They "empty themselves by a single duct through the spinneret on the floor (labium) of the mouth." In the Ant-lion (*Myrmeleon*) the silk is spun from "a slender telescopic-like spinneret, placed at the extremity of its body," and Westwood also states that the larva of *Chrysopa* spins a cocoon "from the spinneret, at the extremity of the body."

These silk glands when taken out of the larva, just as it is about ready to transform, are readily prepared as "gut" for fish-lines, etc., by drying on a board.

In the Bees these glands are largely developed to produce a sufficient amount of salivary fluid to moisten the dry pollen of flowers, before it enters the œsophagus. "Bee-bread" consists of pollen thus moistened and kneaded by the insect. The Honey-bee also dissolves, by the aid of the salivary fluid, the wax used in making its cells. Newport believes this fluid is alkaline, and forms a solvent for the otherwise brittle wax, as he has seen this insect "reduce the perfectly transparent thin white scales of newly secreted wax to a pasty or soapy consistence, by kneading it between its mandibles, and mixing it with a fluid from its mouth, before applying it to assist in the formation of part of a new cell."

Insects have no true *liver;* its functions being performed "by the walls of the stomach, the internal tunic of which is composed of closely-aggregated hepatic cells." (Siebold.) In the Spiders and Scorpions, however, there is a liver distinct from the digestive canal. In the Spiders it is very large, enveloping most of the other viscera.

Fig. 45. Alimentary tube of *Corydalus cornutus*. *a*, œsophagus; *b*, proventriculus; *c*, ventriculus; *d*, large intestine; *e*, urinary tubes; *f*, cœcum; *g*, testis or ovary.—*From Leidy*.

Siebold states that in some insects the ileum has glandular appendages whose product is perhaps analogous to the *pancreatic fluid.* In the larva of insects is found the *corpus adiposum*, or fat-body, in the form of large lobes of fat-cells which spread through the intervals of the viscera in the general cavity of the body. It is interpenetrated and retained in place by numerous tracheæ.

The Circulatory System. The vascular, or circulatory, system is not a closed sac as in the Worms and Vertebrates. The organs of circulation consist of a contractile, articulated dorsal vessel, or so-called "heart," which terminates in a cephalic aorta. The dorsal vessel receives the veinous current through the lateral valvular openings and pumps the blood into its prolongation or cephalic aorta, whence it escapes, traversing the body in all directions, in regular currents, which do not have, however, vascular walls. "In this way, it penetrates the antennæ, the extremities, the wings, and the other appendages of the body, by arterial currents, and is returned by those of a veinous nature. All the veinous currents empty into two lateral ones, running towards the posterior extremity of the body, and which enter, through lateral orifices, the dorsal vessel." (Siebold.)

"The *blood* of the Insecta is usually a colorless liquid, though sometimes yellowish, but rarely red. In this liquid are suspended a few very small, oval, or spheroidal corpuscles, which are always colorless, have a granular aspect, and are sometimes nucleated.

"The *dorsal vessel*, which is constricted at regular intervals, is always situated on the median line of the abdomen, being attached to the dorsal wall of its segments by several triangular muscles whose apices point outwards. Its walls contain both longitudinal and transverse fibres, and, externally, are covered by a thin peritoneal tunic. Internally, it is lined by another very fine membrane, which, at the points of these constrictions, forms valvular folds, so that the organ is divided into as many chambers as there are constrictions. Each of these chambers has, at the anterior extremity on each side, a valvular orifice which can be inwardly closed. The returning

blood is accumulated about the heart and enters into it during the diastole of each of its chambers, through the lateral orifices (Fig. 46 *i*). It then passes, by the regularly successive

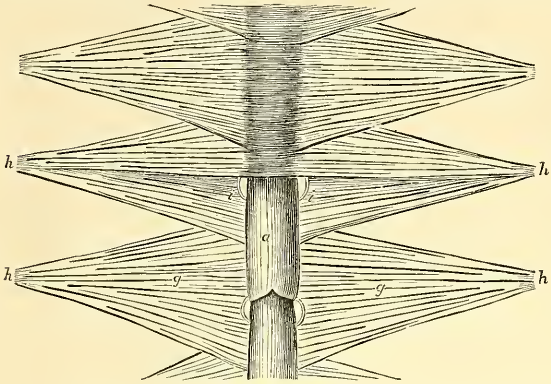


Fig. 46.

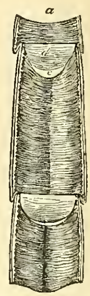


Fig. 47.

contractions of the heart, from behind forwards into the aorta, which is only a prolongation of the anterior chamber. This aorta consists of a simple, small vessel, situated on the dorsal surface of the thorax (Fig. 44 *e*, *f*), and extending even to the cephalic ganglion, where it either ends in an open extremity, or divides into several short branches which terminate in a like manner. The length of the dorsal vessel depends, in all the three states of insects, upon that of the abdomen. The number of its chambers is very variable, but is, most usually, eight.

"The blood, after leaving the aorta, traverses the body in currents which are also extravascular, and in this way bathes all the organs. The newly-prepared nutritive fluid passes through the walls of the digestive canal in which it is found, into the visceral cavity, and thence directly into the blood. Latterly, this extravascular circulation has been called in question, but its presence may be easily and directly observed

FIG. 46. Part of the dorsal vessel or heart of *Lucanus cervus*; *a*, the posterior chambers (the anterior chambers are covered by a part of the ligaments which hold the heart in place). *i*, the auriculo-ventricular openings; *g*, *g*, the lateral muscles fixed by the prolongations *h*, *h*, to the upper side of the abdomen.—*From Straus Durckheim.*

FIG. 47. Interior of the dorsal vessel; *a*, the inner walls with their circular fleshy fibres; *c*, the auriculo-ventricular opening; with its semilunar valve (*c*), in front of which is *d*, the interventricular valvule.—*From Straus Durckheim.*

with very many perfect Insecta and their larvæ. The vascular walls, supposed to have been seen at certain points, are, undoubtedly, the result of some error of observation or interpretation. This is also true of the pulsatile organs supposed to have been observed in the legs of many water-bugs, and which were thought to affect the circulation."

Blanchard and Agassiz believe in a "peritracheal circulation," and other observers agree that the course of the circulation is along the tracheæ, *i.e.* that the blood circulates in the space between the loose peritoneal envelope and the trachea itself. Professor H. J. Clark objects to this view that the blood disks are too large to pass through such an exceedingly minute space as the distance between the trachea and its enveloping, or peritoneal, wall.

Newport thinks that there are actual blood vessels distributed from the heart and "passing transversely across the dorsal surface of each segment in the pupa of *Sphinx*. If they be not vessels distributed *from* the heart, it is a somewhat curious circumstance that the whole of the blood should be first sent to the head of the insect, and the viscera of the abdominal region be nourished only by the returning blood, which has in part passed the round of the circulation."

Newport also describes in *Sphinx* the *supra-spinal*, or great ventral vessel which lies in the abdomen just over the nervous cord, and which is also found in the Scorpion and Centipede. He believes "this vessel to be the chief means of returning the blood from the middle and inferior portion of the body to the posterior extremity of the dorsal vessel or heart." He strongly suspects that anteriorly this great ventral vessel is connected with the aorta. The circulation of Insects, therefore, is probably as much a closed one as in the Myriapods, for he states that the "blood certainly flows in distinct vessels, at least in some parts of the body in perfect insects, and that vessels exist even in the larva." Observations on the vascular system are exceedingly difficult from the delicate structure of the vessels, and the subject needs renewed observations to settle these disputed points.

The blood is forced through the vessel into the body by regular pulsations. Herold counted thirty to forty in a minute in a

full-grown caterpillar; we have counted about sixty a minute in the recently hatched larva of *Diplax*. During excitement, the number of pulsations increases in rapidity. Newport found the pulsations in a bee, *Anthophora*, when quiet, to be eighty a minute; but when "the insects were quite lively, and had been exposed to the sun for an hour or two, the number of pulsations amounted to one hundred and forty."

He found that the *number* of pulsations decreased after each moult of the larva of *Sphinx ligustri*, but increased in *force;* when it was full grown and had ceased feeding it was thirty. "After it had passed into the pupa state the number fell to twenty-two, and afterwards to ten or twelve, and, during the period of hibernation, it almost entirely ceases; but in the perfect insect it rose from forty-one to fifty, and when excited by flight around the room it was from one hundred and ten to one hundred and thirty-nine."

ORGANS OF RESPIRATION. All insects breathe air, or, when they live in the water, respire, by means of branchiæ, the air mixed mechanically with water. Respiration is carried on by an intricate system of tubes (pulmonary tracheæ) which open by pores (spiracles or stigmata) in the sides of the body; or, as in aquatic insects, by branchiæ, or gill-like flattened expansions of the body-wall penetrated by tracheæ (branchial tracheæ).

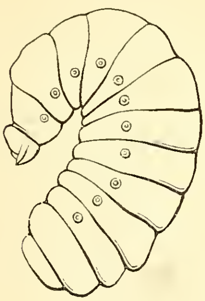


Fig. 48.

There are sometimes eleven spiracles, or breathing-holes (Fig. 48), on each side of the body; each consisting of an oval horny ring situated in the peritreme and closed by a valve, which guards the orifice (Fig. 49). Within this valve is a chamber closed within by another valve which covers the entrance into the tracheæ. The air-tube itself (Fig. 50) consists of "an external

FIG. 48. Larva of the Humble-bee just beginning to change to a pupa, showing eleven pairs of stigmata. In the adult bee, only the fourth pair is apparent, the remaining pairs being concealed from view, or in part aborted. In most insects there are usually only nine pairs of stigmata.—*Original.*

serous, and an internal mucous membrane, inclosing between them a spirally convoluted fibre, thus giving great strength and flexibility to the tube."

Nearly all the air enters through the thoracic and first abdominal spiracles, so that on pinching most insects on the thorax they can be easily deprived of breath and killed.

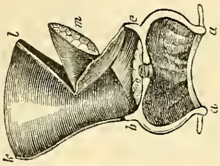


Fig. 49.

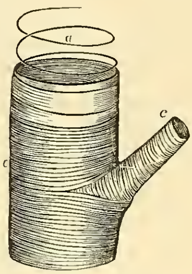


Fig. 50.

"In some aquatic larvæ such as those of *Dyticidæ*, *Eristalis* (Fig. 51, pupa), and *Ephydra*, and also in some perfect insects, as in *Nepa* and *Ranatra*, the parts supporting the stigmata are prolonged into slender tubes, through which the insect, on rising to the surface, breathes the atmospheric air.

Agrion (Fig. 52) affords a good instance of branchiæ or gill-like expansions of the crust, or skin. It is supposed that these false gills, or branchiæ, "absorb the air from the water, and convey it by the minute ramifications of the tracheal vessels, with which they are abundantly supplied, and which terminate in single trunks, into the main tracheæ, to be distributed over the whole body, as in insects which live in the open atmosphere." (Newport.)

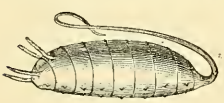


Fig. 51.

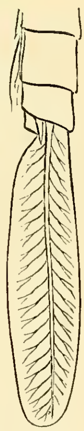


Fig. 52.

Of branchiæ there are three kinds. The first, as in the larvæ and pupæ of Gnats, consist of slender filaments arranged in tufts arising from a single stem. In the larva of *Gyrinus* and the aquatic caterpillar of a moth,

FIG. 49. Chamber leading into the trachea; *a*, *a*, external valve protecting the outer opening of the stigma, or breathing hole; *b*, *c*, *c*, inner and more complicated valve closing the entrance into the trachea (*l*, *k*); *m*, conical occlusor muscle closing the inner orifice.— *From Straus Durckheim.*

FIG. 50. Portion of a trachea divested of its peritoneal envelope. *a*, spirally convoluted fibre, closely wound around the trachea, as at *e*; *c*, origin of a secondary tracheal branch.— *From Straus Durckheim.*

FIG. 52. One of the three gill-like appendages to the abdomen of the larva and pupa of *Agrion* enlarged, consisting of a broad leaf-like expansion, permeated by tracheæ which take up by endosmosis the air contained in water.— *Original.*

Hydrocampa stratiolata, they form short stiff bristles placed along the side of the body. *Agrion* and *Ephemera*, in their larval stages, afford the second kind of branchiæ, and *Libellula* the third kind, or internal gill, situated in the colon. The Mosquito breathes both by branchiæ which form large club-shaped organs, and by lateral filaments.

In those insects that fly, most of the tracheæ are often dilated into *air-vesicles*, so that by filling and emptying them of air the insect can change its specific gravity. That their use is also to lighten the body is shown by their presence in the heavy mandibles and head of the male of *Lucanus cervus*. In the adult Humble-bee there are two very large vesicles at the base of the abdomen. These vesicles are not found in the larvæ, or in the adult forms of creeping insects.

The *act of respiration* consists in the alternate dilation and contraction of the abdominal segments, the air entering the body chiefly at the thoracic spiracles. As in the Vertebrates the frequency of the acts of breathing increases after exertion. "When an insect is preparing itself for flight, the act of respiration resembles that of birds under similar circumstances. At the moment of elevating its elytra and expanding its wings, which are, indeed, acts of respiration, the anterior pairs of spiracles are opened, and the air rushing into them is extended over the whole body, which, by the expansion of the air-bags, is enlarged in bulk, and rendered of less specific gravity; so that when the spiracles are closed at the instant the insect endeavors to make the first stroke with and raise itself upon its wings, it is enabled to rise in the air, and sustain a long and powerful flight with but little muscular exertion. In the pupa and larva state respiration is performed more equally by all the spiracles, and less especially by the thoracic ones."

During hibernation the act of breathing, like the circulation of the blood, almost entirely ceases, and the heat of the body is greatly lowered. Indeed Newport has shown that the *development of heat* in Insects, just as in Vertebrates, depends on the "quantity and activity of respiration, and the volume and velocity of the circulation." The Humble-bee, according to Newport, possesses the *voluntary power* of generating heat by breathing faster. He says, confirming Huber's observations,

"the manner in which the bee performs her incubatory office is by placing herself upon the cell of a nymph (pupa) that is soon to be developed, and then beginning to respire at first very gradually. In a short time the respirations become more and more frequent, until at length they are increased to one hundred and twenty, or one hundred and thirty per minute. The body of the insect soon becomes of a high temperature, and, on close inspection, is often found to be bathed with perspiration. When this is the case the temperature of the insect soon becomes reduced, and the insect leaves the cell, and another bee almost immediately takes her place. When respiration is performed less violently, and consequently less heat is evolved, the same bee will often continue on a cell for many hours in succession. This extreme amount of heat was evolved entirely by an act of the will in accelerating the respiratory efforts, a strong indication of the relation which subsists between the function of respiration and the development of animal heat."

Organs of Secretion. The urinary vessels, or what is equivalent to the kidneys of the higher animals, consist in Insects of several long tubes which empty by one or two common secretory ducts into the posterior or "pyloric" extremity of the stomach. There are also *odoriferous glands*, analogous to the cutaneous glands of vertebrates. The liquid poured out is usually offensive, and it is used as a means of defence. The Bees, Wasps, Gall-flies, etc., and Scorpions, have a poison-sac (Fig. 54 *g*) developed in the tip of the abdomen. The bite of the Musquito, the Horse-fly, and Bed-bug is thought by Newport to be due to the simple act of thrusting their lancet-like jaws through the skin, and it is not known that these and other insects which bite severely eject any poison into the wound. But in the spiders a minute drop of poison exudes from an orifice at the end of the mandibles, "which spreads over the whole wound at the instant it is inflicted." This poison is secreted by a gland lodged in the celphalo-thorax, and which is thought by Audouin to correspond in position to the salivary apparatus and the silk glands of the Winged Insects.

Organs of Generation. We have already described the external parts. The internal parts of the male insect consist,

first, of the *ductus ejaculatorius*, which opens into the external intromittent organ. This duct extends backwards, connecting with the *vesiculæ seminales*, which lead by the *vasa differentia* to the *testes* (Fig. 53). The latter are usually rounded glandular bodies, sometimes, as in *Melolontha* and *Lucanus*, numbering six on a side. These organs lie in the abdominal cavity, usually above and on each side of the alimentary canal.

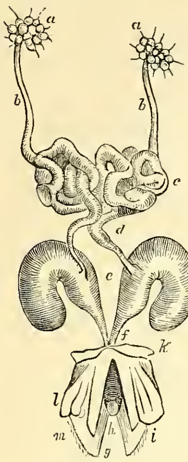


Fig. 53.

The sperm, or fertilizing fluid, contains very active spermatic particles which are developed in large cells in the testes, where they are united into bundles of various forms.

In the female, the internal reproductive organs (Fig. 54) are more simple than those of the other sex. The external opening of the female is situated at the end of the oviduct, that leads by two tubes to the ovary, which consists of two or more tubes (in the Queen Bee one hundred and sixty to one hundred and eighty) in which the ova are developed. On the upper side

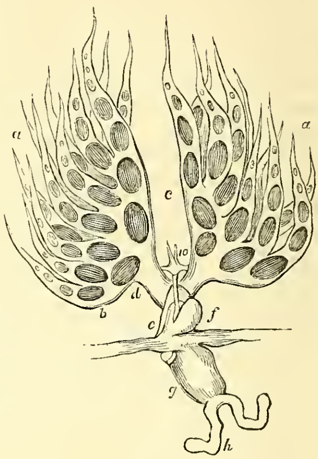


Fig. 54.

Fig. 53. Male organs of *Athalia centifoliæ*. *h*, the penis, or external portion, in which the *ductus ejaculatorius* (*f*) terminates, which extends backwards, and is connected with the *vesiculæ seminales* (*e*), and *vasa differentia* (*d*) which are connected with the *epididymis* (*b*), and the *testes* (*a*). *i* and *l*, two pairs of horny plates, surrounded by a horny ring (*k*). *i*, horny prehensile hooks attached to *k*. *m*, two elongated muscular parts inclosing the penis (*h*). — *From Newport.*

Fig. 54. Female organs of generation of *Athalia centifoliæ*. *a*, *b*, *c*, the eighteen ovarial tubes originating from each of the two oviducts (*e*), and containing the immature eggs; *f*, the spermatheca; *g*, poison-sac, the poison being secreted in the secretory vessels *h*. The poison flows through the oviduct into the sting and thence into the wound made by the sting. 10, the terminal ganglia of the nervous cord. — *From Newport.*

of the oviduct are from one to five appendages, the most important of which is the *spermatheca* (the others being sebaceous glands), which receives the fertilizing fluid of the male during sexual union, and in which, according to Darwin, the male element "is enabled to keep alive four or five years."

Insects bisexual. With the exception of the *Tardigrades*, which are doubtfully referred to the Mites (*Acarina*), there are no hermaphrodites among Insects, that is, there are no individuals having both male and female organs, and capable of self-impregnation. On the contrary, the sexes are distinct; Insects are bisexual.

Hermaphrodites, so-called. Cases not unfrequently occur in which from arrest of development of the embryo, the sexual organs are imperfectly developed, so as to present the appearance of being both male and female. "Siebold has investigated some hermaphrodite Honey-bees belonging to the Italian race, obtained from a Dzierzon hive at Constance. He found in many of them a combination of sexual characters, not only in the external parts, but also in the generative organs. The mixture of the external characters is manifested sometimes only in the anterior or posterior part of the body, sometimes in all parts of the body, or only in a few organs. Some specimens present male and worker characters on the two sides of the body. The development of the internal organs is singularly correlated with these peculiarities of external organization. The sting, with its vesicle and gland, is well developed in hermaphrodites with the abdomen of the worker; soft in those with the drone-abdomen. The seminal receptacle, when present, is empty. The ovaries contain no ova. In the hermaphrodites with the drone-abdomen, the male sexual organs are well developed, and the testes contain spermatozoids. Frequently with testicular and ovarian organs present on each side, the epididymis and copulatory apparatus are well developed, and an imperfect poison-apparatus exists. In these cases the tube contains spermatozoids, but there are no ova in the ovaries. The hermaphrodites are thrown out of the cell by the workers as soon as they emerge, and speedily perish. Siebold ascribes the production of these hermaphrodites to an imperfect fecundation of the ovum." (Zeitschrift für Wissenschaftliche Zoologie, 1864, p. 73. See Günther's Zoölogical Review for 1864.)

Mr. Dunning describes a specimen of *Fidonia piniaria*, "which was sexually a female, and the abdomen was apparently distended with eggs; the general color was midway between the colors of the ordinary male and female, but the size and markings were those of the male. (Transactions Entomological Society, London, Aug. 7, 1865.) Professor Westwood states that "he had an Orange-tip Butterfly (*Anthocharis cardamines*), which was female in every respect, except that on the tip of one fore-wing were about a dozen of the bright orange scales which characterize the male."

THE EGG. Professor H. J. Clark (Mind in Nature) defines an egg to be a globule surrounded by the vitelline membrane, or yolk-envelope, which is protected by the *chorion*, or egg-shell, consisting of "two kinds of fluid, *albumen* and *oil*, which are always situated at opposite sides or poles." "In the earliest stages of all eggs, these two poles shade off into each other," but in the perfectly developed egg the small, or albuminous pole, is surrounded by a membrane, and forms the Purkinjean (germinal) vesicle; and thirdly and last, the innermost of the three globules is developed This last is the Wagnerian vesicle, or *germinal dot*. The oily matter forms the *yolk*. Thus formed, the egg is the *initial animal*. It becomes an animal after contact with the male germs (unless the product of organic reproduction), and the egg-shell or chorion is to be considered as a protection to the animal, and is thrown off when the embryo is hatched, just as the larva throws off its skin to transform into the pupa. So that the *egg-state* is equivalent to the larva state, and hence there are four stages in the life of an insect, *i. e.* the egg, the larva, the pupa, and the imago, or adult state.

The egg is not always laid as a perfect egg (Clark). It sometimes, as in the Ants, continues to grow after it is laid by the parent, like those of frogs, which, according to Clark, "Are laid before they can hardly be said to have become fully formed *as eggs*." Again, others are laid some time after the embryo has begun to form; and in some, such as *Melophagus* and *Braula*, the larva is fully formed before it is expelled from the oviduct.

Eggs are usually small in proportion to the size of the parent; but in many minute forms (*i.e. Pulex*, *Pediculus*, etc.) they are proportionately much larger. In shape eggs are either spherical or oblong. In some there are radiating appendages at one end, as in those of *Nepa* and *Ranatra*; or they are provided with a single stalk, as in *Chrysopa*, *Cynips*, and *Ophion*.

The eggs of most Hymenoptera, Diptera, and many Coleoptera are usually cylindrical; those of Lepidoptera are more generally spherical. The eggs of the Mosquito are laid in a boat-shaped mass, which floats on the surface of quiet pools, while those of the *Chrysopa*, or Lace-winged Fly (Fig. 55), are supported on long pedicels. They are almost invariably laid near or upon objects destined to be the food of the future larva. Thus the *Copris*, or "Tumble-bug," places its egg in a ball of dung which it rolls away to a secure place; the Flesh-fly oviposits on meat; and all vegetable-feeders lay their eggs on the food-plant where the larva, upon its exit from the egg, shall readily find an ample supply of food.

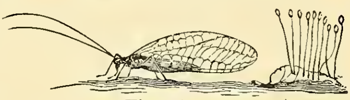


Fig. 55.

The posterior end of the egg is more often the fixed one, and it may thus be distinguished from the anterior pole. In the eggs of some Diptera and Orthoptera, the ventral side of the embryo, according to Gerstaecker, corresponds to the convex side of the egg, and the concave side of the latter corresponds to the dorsal region of the embryo.

The surface of the chorion, or egg-shell, which is dense and brittle, is often covered by a mosaic-work of more or less regular facets. In many small eggs the surface is only minutely granulated, or ornamented with ribs and furrows, as in those of many Butterflies.

The Micropyle. On the anterior end (though sometimes at both ends) of the egg is one or more pores of exceeding minuteness, through which the spermatozoa (more than one of which, according to Darwin, is requisite to fertilize an ovule) enter to fertilize the egg-contents. In some cases these micropyles are scattered over the whole surface of the egg. Fig. 56 *a* represents the micropyles of *Nepa cinerea*, consisting

of a whorl of long bristles. Those of *Locusta viridissima* (Fig. 56 *b*) slightly resemble toodstools. Fig. 56 *c* represents the anterior pole of the egg with the micropyles of *Pyrhocoris apterus*. — (*From Gerstaecker.*)

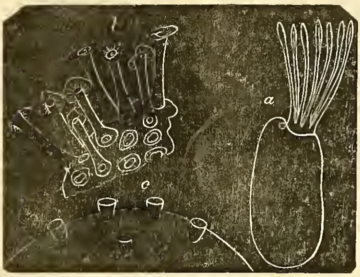


Fig. 56.

This contact of a male sperm-cell with the yolk is the fertilization of the egg. From this moment begins the life of the embryo. Fertilization of the female germ by means of the male sperm, through the congress of the sexes, is the rule with bisexual animals, but there are exceptions among insects. An embryo may start into being without the interposition of the male; to this mode of generation has been applied by Leuckart the term *Parthenogenesis*. Among certain species of insects there are some individuals which, by a sort of budding process, and without the aid of the male element, throw off summer broods, consisting of "asexual" individuals, which, as winter approaches, are succeeded by a brood of true males and females, the latter of which lay eggs. This phenomenon, called by Steenstrup "alternation of generations," has been observed among a comparatively few species, and the apparent design of such an anomalous mode of reproduction is to afford an immense number of individuals, thus providing for the continuance of the species. The individuals in whom this budding process takes place are called "asexual" because, though they may resemble the female sex outwardly, their sexual organs are only partially developed. This budding process is the same in kind with that observable in the Jelly-fish, which throw off by parthenogenesis, or alternations of generations, summer broods of immense extent, but in winter propagate by true eggs. Huxley has studied the development of Aphis by parthenogenesis, the anomalous nature of which has previously been discovered by Bonnet, Trembly, Lyonet, Degeer, Kyber, and others, and arrives at the following conclusions:

"1. Ova deposited by impregnated female *Aphides* in autumn are hatched in the spring.

2. From these ova viviparous, and, in the great majority of cases, apterous forms proceed.

3. The broods to which these give rise are either winged or apterous, or both.

4. The number of successive broods has no certain limit, but is, so far as we know at present, controlled only by temperature and the supply of food.

5. On the setting in of cold weather, or in some cases on the failure of nourishment, the weather being still warm, males and oviparous females are produced.

6. The males may be either winged or apterous.

7. So far as I am aware, there is no proof of the existence of any exception to the law that the oviparous female is apterous.

8. Viviparous *Aphides* may hybernate, and may co-exist with oviparous females of the same species." (Linnæan Transactions, xxii, p. 198.)

The origin of the viviparous, asexual, or *agamic* (from the Greek *a*, without; *game*, marriage) individual, as it may be more properly called, is, up to a certain stage, the same as that of the true egg, *i.e.* until the germ (*pseudovum*) of the former is detached from the false ovary (pseudovarium). "From this point onwards, however, the fate of the pseudovum is different from that of the ovum. The former begins at once to be converted into the germ; the latter accumulates yelk-substance, and changes but little. Both bodies acquire their membranous investment rather late; within it the pseudovum becomes a living larva, while the ovum is impregnated, laid, and remains in a state of rest for a longer or shorter period.

"Although, then, the pseudovum and the ovum of *Aphis* are exceedingly similar in structure for some time after they have passed out of the condition of indifferent tissue, it cannot be said that the sole difference between them is, that the one requires fecundation and the other not. When the ovum is of the size of a pseudovum which is about to develop into an embryo, and, therefore, long before fecundation, it manifests its inherent physiological distinctness by becoming, not an embryo, but an ovum. Up to this period the influence of fecundation has not been felt; and the production of ova, instead of

pseudova, must depend upon a something impressed upon the constitution of the parent before it was brought forth by its viviparous progenetrix." (Huxley.)

Siebold has also shown that the "ova of the Queen-bee produces females or males, according as they are fecundated or not. The fecundated ovum produces a queen or a neuter according to the food of the larva and the other conditions to which it is subjected; the unfecundated ovum produces a drone." This is analogous to the agamic reproduction of Aphis, and "demonstrates still more clearly the impossibility of drawing any absolute line of demarcation histologically between ova and buds."

This process of reproduction is not known in the Myriapods. It occurs among the mites (*Acarina*), and occurs in isolated genera of Hemiptera (*Aphis*, *Chermes*, *Lecanium*, and *Aspidiotus* according to Gerstaecker).

Among Lepidoptera the Silk-moth sometimes lays fertile eggs without previous sexual union. This very rarely happens, for M. Jourdain found that, out of about 58,000 eggs laid by unimpregnated silk-moths, many passed through their early embryonic stages, showing that they were capable of self-development, but only twenty-nine out of the whole number produced caterpillars. (Darwin.) Several other moths* have been found to lay fertile eggs without previous sexual union, and among Hymenoptera, *Nematus ventricosus*, *Cynips*, *Neuroterus*, perhaps *Apophyllus* (according to Gerstaecker), and *Cynips spongifica* (according to Walsh, Proceedings of

*We give a list from Gerstaecker (Bronn's Classen und Ordnungen des Thierreichs) of all the known cases of agamic reproduction in this suborder, with the number of times the phenomenon has been observed, and the names of the observers.

Sphinx ligustri, once (Treviranus).
Smerinthus populi, four times (Nordmann).
Smerinthus ocellatus, once (Johnston).
Euprepia caja, five times (Brown, etc.).
" *villica*, once (Stowell).
Telea Polyphemus, twice (Curtis).
Gastropacha pini, three times (Scopoli, etc).
Gastropacha quercifolia, once (Basler).
" *potatoria*, once (Burmeister).
Gastropacha quercus, once (Plieninger).
Liparis dispar, once (Carlier).
"*Egger moth*" (? *Liparis dispar*), (Tardy, Westwood).
Liparis ochropoda, once (Popoff).
Orgyia pudibunda, once (Werneburg).
Psyche apiformis, once (Rossi).
" *helix* (Siebold).
Solenobia lichenella (Siebold).
" *triquetrella* (Siebold).
Bombyx mori, several times.

The subject has been also discussed by Siebold in his work entitled, A true Parthenogenesis in Lepidoptera and Bees; by Owen, in his "Parthenogenesis," and by Sir J. Lubbock in the Philosophical Transactions, London, vol. 147, pt. 1.

the Entomological Society of Philadelphia). Parthenogenesis, or agamic reproduction, is, then, the result of a budding process, or cell-growth. This process is a common mode among the Radiates, the low Worms, and the Crustaceans. Metamorphosis is simply a series of marked stages, or periods, of growth; and hence growth, metamorphosis, and agamic reproduction are morphologically identical. All animals, therefore, as well as plants, grow by the *multiplication of cells.*

After hearing the surprising revelations of Bonnet, Reaumur, Owen, Burnett, and Huxley on the asexual mode of generation in the Aphis, we are called to notice still a new phase of reproduction. None of the observers just mentioned were accustomed to consider the virgin aphis as immature, but rather as a wingless *adult* Plant-louse. But Nicolas Wagner, Professor of Zoölogy at Kasan,* supported by able vouchers for the truth of his assertions, both in Russia and in Germany, who have repeated and thoroughly tested his observations, has observed an asexual reproduction in the *larva* of a Cecidomyian fly, *Miastor metraloas* Meinert, and Meinert has observed it in this species and the *Oligarces paradoxus* Meinert.

Says Dr. R. Leuckart, whose article† we have drawn largely upon in the present account, "This reproduction was said to commence in autumn, to continue through the winter and spring, giving origin, during the whole of this period, to a series of successive generations of larvæ, until, finally, in June, the last of them were developed into perfect and sexually mature animals. The flies, then, as usual, after copulation, lay eggs, and thus recommence the developmental cycle just described."

Professor Leuckart has observed these facts anew in the larvæ of a species of dipterous gall-fly, and which he believes distinct from the Russian species, found under the bark of a half dead apple-tree that was attacked by fungi. The young are developed within the body of the larva-like parent from a

* K. E. Von Baer, "Report on a New Asexual Mode of Reproduction observed by Professor Wagner in Kasan." Bull. Acad. St. Petersburg, 1863, pt. vi, p. 239. Also, Wagner in the Journal of the University of Kasan, 1861.

† On the Asexual Reproduction of Cecidomyia Larvæ. Annals and Magazine of Natural History, March, 1866. Translated from Zeitschrift für Wissenschaftliche Zoologie, Bd. xiv.

"germ-ball" essentially agreeing with the ovary, and the asexual larvæ begin life as egg-like bodies developed from this germ-ball, just as eggs are developed in the little tubes of which the ovary is an aggregation. Hence these worms *bud* out from the germ-stock, just as we have seen in the case of the Aphides. Leuckart and Wagner farther agree, that "the so-called chorion never being formed in either of them, the vitellus [yolk] remains without that envelope which has so remarkable and peculiar a development in the true egg of insects." . . . . "The processes of embryo-formation agree in all essential points with the ordinary phenomena of development in a fecundated egg, exactly as has been proved (by Huxley) to be the case in the *Aphides*." . . . . "The only difference consists in the germ-chambers of the Cecidomyide larvæ separating from the germ-stock, and moving about freely in the cavity of the body, whilst in the Aphides they remain permanently attached, and constitute an apparatus which, in its form and arrangement, reproduces the conditions of the female organs."

Thus we can neither pronounce these so-called *larvæ* to be larvæ so long as they produce young, neither are they actual males or females; they are what Leuckart calls *asexual* forms, which produce false-eggs (pseudova of Huxley, as restricted by Leuckart). This is paralleled by the asexual Aphides, and among Hymenoptera by the worker Ants, and worker, or, as they were formerly called, neuter Bees, the latter of which have been known to produce young without the interposition of the male; thus the two sexes, at least the females, are *dimorphic*, *i. e.* for certain exigencies of life they are specialized into two distinct forms, one (as in the asexual *Aphis*) to produce an unlimited number of young during the summer; the other and sexual, normal form to produce in the autumn a comparatively limited number of eggs.

Dimorphism is intimately connected with agamic reproduction. Thus the asexual Aphis, and the perfect female, may be called dimorphic forms. Or the perfect female may assume two forms, so much so as to be mistaken for two distinct species. Thus *Cynips quercus-spongifica* occurs in male and female broods in the spring, while the fall brood of females were

described as a separate species, *C. aciculata*. Mr. B. D. Walsh considers the two sets of females as dimorphic forms, and he thinks that *O. aciculata* lays eggs which produce *C. quercus-spongifica*.

Huber supposes there are two sizes of the three forms (*i. e.* male, female, and worker) of *Bombus*, one set being a little larger than the other.

Alfred Wallace has discovered that there are two forms of females of *Papilio Memnon* of the East Indies; one is normal, having its wings tailed and resembles a closely allied species, *Papilio Coön*, which is not dimorphous, while the other is tailless, resembling its tailless male. *Papilio Pammon* has three sorts of females, and is hence "trimorphic." One of its forms predominates in Sumatra, and a second in Java, while a third, (described as *P. Romulus*) abounds in India and Ceylon. *P. Ormenus* is trimorphic, as Mr. Wallace obtained in the island of Waignion, "a third female quite distinct from either of the others, and in some degree intermediate between the ordinary male and female." Much the same thing occurs in the North American *P. Turnus*. *Papilio Glaucus* is now known to be a dimorphic form of the former butterfly, both having, according to Mr. Uhler, been bred from the same batch of eggs. The ordinary form of the female of *P. Turnus* occurs north of lat. 37°, while the dimorphic form, *P. Glaucus*, occurs south of 42°.

The male sex also presents dimorphic forms. Mr. Pascoe (Proceedings of the Entomological Society of London, 1862, p. 71) states that there are dimorphic forms of *Anthribidæ;* that they occur in the male of *Stenocerus* and *Micoceros*. Six species of *Dytiscus* have two female forms, the most common having the elytra deeply sulcate, while in the rarer forms the elytra are smooth as in the male.

There is a tendency, we would observe, in the more abnormal of the two sexual forms, to revert to a lower type. Thus the agamic Aphis is more generally wingless, and the tailless female butterfly mimics the members of a lower genus, *Pieris*. The final cause of Dimorphism, like that of agamic reproduction, is the continuance of the species, and is, so far as yet known, an exceptional occurrence.

Mimetic forms. Many insects often resemble, in a remark-

able manner, those of other groups. They are called mimetic forms. Insects are related to each other by analogy and affinity. Thus the truly tailless species of *Papilio*, *i. e.* those where the tail is absent in both sexes, are related by affinity to *Pieris*, which has rounded hind wings. They also stand next to *Pieris* in the system of Nature. But there are, on the other hand, mimetic forms, which borrow the features of groups far above them in the natural system. Thus the *Sesia* resembles a Bee, *Bombylius* and *Laphria* resemble *Bombus;* the Syrphus flies are easily mistaken for Wasps. So in the second series of suborders of Insects, *Forficula* resembles the *Staphylinus; Termes* resembles the true Ant; *Psocus*, the *Aphis; Ascalaphus* resembles *Papilio ; Mantispa* recalls the Orthopterous *Mantis*, and *Panorpa* reminds us of the *Tipulæ* (*Bittacus* being strikingly analogous to the Dipterous *Bittacomorpha*). Thus these lower, more variable groups of insects strive, as it were, to connect themselves by certain analogous, mimetic forms, with the more stable and higher groups.

Comprehensive types are mimetic forms which combine the characters of other and generally higher groups. Thus each Neuropterous family contains mimetic forms which ally them strongly with some one of the six other suborders of insects. The early fossil insects are remarkable for combining the characters of groups which appear ages after. The most remarkable comprehensive type is a Carboniferous insect, the *Eugereon Boeckingi* mentioned farther on.

HYBRIDITY. Hybrids are sometimes produced between different species, but though it is known that different genera unite sexually, we know of very few authentic instances of the production of hybrids therefrom. One is related by Mr. Midford, who exhibited at the March 4th (1861) meeting of the London Entomological Society, hybrids produced from a male *Phigalia pilosaria*, and a female *Nyssia hispidaria*. "The males resemble *N. hispidaria*, but in color have the lighter and greener tint and transparency of wing of *P. pilosaria*."

THE DEVELOPMENT OF INSECTS. Immediately after the fertilization of the egg, the first act in the organization of the

future embryo is the formation of the germinal layer, or *blastoderm* (from the Greek, meaning primitive skin). This layer is formed at the surface out of a surface-layer of larger, often nucleolated, cells which nearly encompass the yolk-mass. At one point there is a break in this cellular layer, and the yolk granules reach to the surface, so that it appears darker than the other parts of the egg. This cellular layer is soon resolved into the blastoderm, or germinal layer, which thickens and narrows, forming a longitudinal band. This is the first stage of the embryo, which lies as a thin layer of cells upon the outer surface of the yolk. Both ends of the body are alike, and we shall afterwards see that its back lies next to the centre of the egg, its future ventral side looking outwards. The embryo is thus bent on itself backwards.

In the next stage the blastoderm divides into a certain number of segments, or joints, which appear as indentations in the body of the embryo. The head can now be distinguished from the posterior end chiefly by its larger size, and both it and the tail are folded back upon the body of the embryo, the head especially being sunk backwards down into the yolk-mass.

In a succeeding stage, as we have observed in the embryo of *Diplax*, a Dragon-fly (Fig. 57), the head is partially sketched

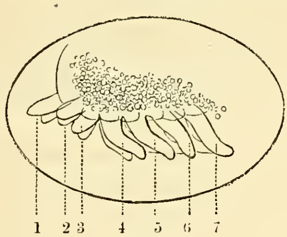


Fig. 57.

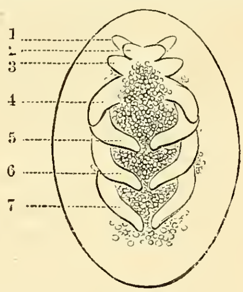


Fig. 58.

out, with the rudiments of the limbs and mouth-parts; and the sternites, or ventral walls, of the thorax and of the two basal rings of the head appear. The anterior part of the head, including the so-called "procephalic lobes" overhangs and con-

FIG. 57. Side view of embryo. The procephalic lobes are not shown. 1, antennæ; 2, mandibles; 3, maxillæ; 4, second maxillæ (labium); 5-7, legs. These numbers and letters are the same in all the figures from 57-60. The under-side (sternum) of six segments are indicated. FIG. 58. Ventral view of the same.

ceals the base of the antennæ. It is probable that more careful observation would have shown the end of the abdomen folded back upon the *dorsal* region, as usual at this period in the embryos of those insects whose embryology has been studied.

The antennæ, mandibles, and maxillæ form a group by themselves, while the second maxillæ (or labium) are very much larger and turned backwards, being temporarily grouped with the legs.

There are traces only of the two basal sterna of the abdomen. This indicates that the basal abdominal segments grow in succession from the base of the abdomen, the middle ones appearing last. The post-abdomen (Fig. 59 A) has probably been developed synchronous with the procephalic lobes, as it is in all insect and crustacean embryos yet observed. As stated by Zaddach, these two lobes in their development are exact equivalents; antero-posterior symmetry is very clearly demarked, the two ends of the body at first looking alike. But in this stage, after the two ends of the body have been evolved from the primitive cell-layer, development in the post-abdominal region is retarded, that of the head progressing with much greater rapidity.

In the next stage (not figured) the yolk is completely walled in, though no traces of segments appear on the back or side of the embryo. The revolution of the embryo has taken place; the post-abdomen being curved *beneath* the body, and the back presenting outwards.

The rudiments of the eyes appear as a darker, rounded mass of cells indistinctly seen through the yolk-granules, and situated at the base of the antennæ. They consist of a few epithelial cells of irregular form, the central one being the largest.

The second maxillæ are a little over twice the length of the first maxillæ and are grouped with the legs, being curved backwards. They are, however, now one-third shorter than the anterior legs. The second maxillary sternum is still visible.

The tip of the abdomen (or post-abdomen) consists of four segments, the terminal one being much the larger, and obscurely divided into two obtuse lobes.

The abdominal sternites are now well marked, and the ner-

vous cord is represented by eight or nine large oblong-square (seen sideways) ganglia, which lie contiguous to each other.

The formation of the eyes, the post-abdomen, the sternites, and median portion of the nervous cord seems nearly synchronous with the closing up of the dorsal walls of the body, though the division of the tegument into segments has not apparently taken place over the yolk-mass.

The succeeding stage (Fig. 59) is signalized by the appearance of the rudiments of the intestine, while the second maxillæ are directed more anteriorly.

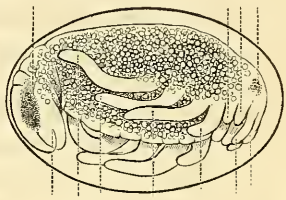


Fig. 59.

In form the body is ovate-cylindrical, and there is a deep constriction separating the post-abdomen from the anterior part of the abdomen.

The terminal (eleventh) ring is immensely disproportioned to its size in the embryo just previous to hatching (see Fig. 61, where it forms a triangular piece situated between its appendages, the anal stylets). At a later period of this stage two more abdominal segments have been added, one to the end of the main body of the abdomen, and another to the post-abdomen. They have been apparently *interpolated* at the junction of the post-abdomen to the abdomen proper. Should this observation be proved to be correct, it may then be considered as a rule that, after reaching a certain number of segments, all additional ones are interpolated between the main body of the abdomen and its terminal segment or segments. This is the law of increase in the number of segments in Worms, and in Myriapods (*Iulus*, according to Newport's observations), in Arachnids (Claparede), and Crustacea (Rathke).

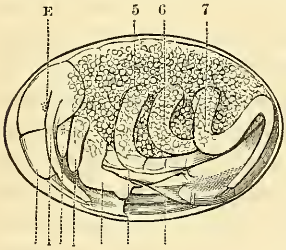


Fig. 60.

The next stage (Fig. 60), is characterized by the differentia-

FIG. 59. An embryo much farther advanced. C, clypeus; E, eye; A, bi-lobed extremity of the abdomen; I, the rudiments of the intestines.

tion of the head into the rudiments of the ophthalmic ring, and the supraclypeal piece, and clypeus, together with the approximation of the second pair of maxillæ, which, when united, form the labium, the extremities of which are now situated in the middle of the body.

The antennæ now extend to the middle of the labium, just passing beyond the extremities of the mandibles and maxillæ. The œsophagus can now be seen going from the mouth-opening situated just beneath the labium. It curves around just behind the eyes. There are at this period no appearances of movable blood-disks or of a dorsal vessel.

The abdomen is now pointed at the extremity and divided into the rudiments of the two anal stylets, which form large, acute tubercles. The yolk-mass is now almost entirely inclosed within the body walls, forming an oval mass.

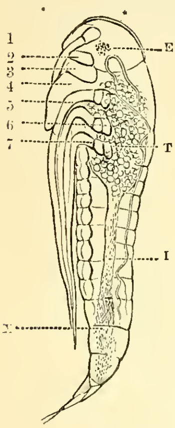


Fig. 61.

Another embryo, observed July 27th, had reached about the same stage of growth. The front of the head, including the antennary segment, is farther advanced than before. The entire head is divided into two very distinct regions; *i.e.* one *before* the mouth-opening (the *preoral* region, including the *ocellary*, or first and second segments; the *ophthalmic*, or third segment, and *antennary*, or fourth segment of the head); and the other *behind* the mouth (*postoral*, consisting of the *mandibular*, or fifth segment, the *first maxillary*, or sixth segment, and the *second maxillary*, or *labial*, being the seventh and last cephalic ring.

At a later period the embryo is quite fully formed, and is about ready to leave the egg. The three regions of the body are now distinct. The articulations of the tergum are present, the yolk-mass being completely inclosed by the tergal walls.

FIG. 61. The embryo taken from the egg, but nearly ready to hatch. T, the dotted line crosses the main trachea, going through the yolk-mass, now restricted to the thoracic region. At X, the tracheæ send off numerous branches around an enlargement of the intestine (colon), where the blood is aerated; better seen in fig. 62. The abdomen consists of eleven segments, the last being a minute triangular piece.

The body is so bent upon itself that the extremities of the second maxillæ just overlap the tip of the abdomen.

The two limbs of the labium are now placed side by side, with the prominent spinous appendage on the outer edges of the tip. These spines are the rudiments of the labial palpi.

The general form of the embryo at a still later period (Fig. 61), on being taken from the egg and straightened out, reminds us strikingly of the Thysanura, and, in these and other respects, tend to prove that the Poduræ and Lepismæ, and allied genera, are embryonic, degraded forms of Neuroptera, and should therefore be considered as a family of that sub-order. Seen laterally, the body gradually tapers from the large head to the pointed extremity. The body is flattened from above downwards. At this stage the appendages are still closely appressed to the body.

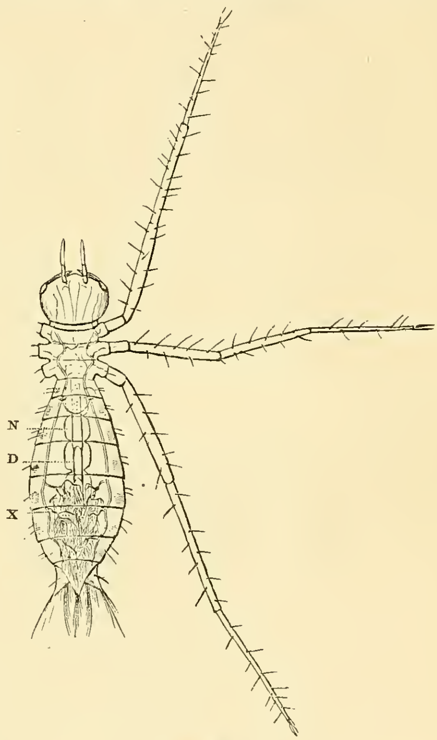


Fig. 62.

Just before the exclusion of the embryo, the legs and mouth-parts stand out freer from the body. The labium, especially, assumes a position at nearly right angles to the body. The antennæ, mandibles, and maxillæ have taken on a more definite form, being like

FIG. 62. The larva just hatched and swimming in the water. N, ventral cord or nervous ganglia; D, dorsal vessel, or "heart," divided into its chambers. The anal valves at the end of the abdomen, which open and shut during respiration, are represented as being open. Both of the dotted lines cross the tracheæ. X, network of the tracheæ, surrounding the cloaca.

that of the young larva, and stand out free from the body. The head is much smaller in proportion to the rest of the body, and bent more upon the breast.

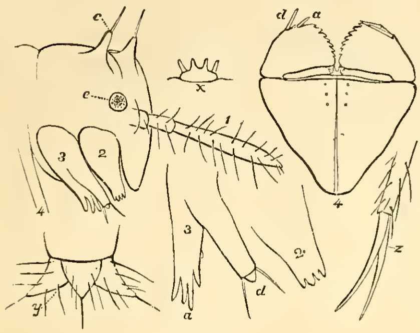


Fig. 63.

The Larva (Fig. 62) when hatched is about five hundredths of an inch in length. The head is now free and the antennæ stand out free from the front. The thorax has greatly diminished in size, while the abdomen has become wider, and the limbs very long; and the numerous minute tubercles, seen in the preceding stage, have given origin to hairs. The dorsal vessel can now, for the first time, be seen. When in motion, the resemblance to a spider is most striking. The flow of blood to the head, and the return currents through the lacunar or venous circulation along the side of the body were easily observed. The vessels were not crowded with blood disks, the latter being few in number, only one or two passing along at a time. Two currents, passing in opposite directions, were observed in the legs.

Fig. 64.

FIG. 63. Side view of the head of the larva of Diplàx before the first moult. *c*, deciduous tubercles terminating in a slender style; their use is unknown; they have not been observed in the full-grown larva. *e*, the compound eyes. 1, the three jointed antennæ, the terminal joint nearly three times as long as the two basal ones. 2, the mandibles, and also enlarged, showing the cutting edge divided into four teeth. 3, maxillæ divided into two lobes: *d*, the outer and anterior lobe, 2-jointed, the basal joint terminating in two setæ; and *a*, the inner lobe concealed from view, in its natural position, by the outer lobe, *d*. 4, the base or pedicel of the second maxillæ, or labium, the expanded terminal portion being drawn separately; *d* and *a*, two movable stout styles representing, perhaps, the labial palpi; the lobe to which they are attached is multidentate, and adapted for seizing prey; on the right side the two styles are appressed to the lobe. *x* represents, perhaps, the ligula; but we have not yet studied its homologies carefully: this part is attached to a transversely linear piece soldered to the main part of the labium. *y*, the 11th abdominal ring, with its pair of conical anal styles. *z*, the last tarsal joint and pair of long slender claws.

FIG. 64. The pupa of Diplax, having rudimentary rings, in which the eyes are much larger, and the legs much shorter than in the recently hatched larva; introduced to be compared with the young larva. Figs. 57–64, *original*.

2

Horatio R. Storer
from
the Author.
April 17th 1848.

From the American Journal of Science and Arts, No. 2, Vol. 36.

DESCRIPTIVE CATALOGUE

OF THE

NORTH AMERICAN INSECTS

BELONGING TO THE

LINNÆAN GENUS SPHINX

IN THE CABINET OF

THADDEUS WILLIAM HARRIS, M. D.,

LIBRARIAN OF HARVARD UNIVERSITY.

DESCRIPTIVE CATALOGUE, &c.

THE insects belonging to the order Lepidoptera have peculiar claims to our attention. In the adult or winged state they are among the most beautiful, and in their previous or caterpillar state are the most injurious of insects. Living while young principally on the leaves of plants, they are at all times more or less exposed to our observation, and too often obtrude themselves on our notice by their extensive ravages. While it is comparatively easy to discover these insects and observe their transformations, the determination of their names and their places in a scientific arrangement is rendered in many cases impossible, and in all exceedingly difficult, to the American student, from the want of suitable descriptive works on this branch of entomology. Having overcome these difficulties myself only at a great expense and much loss of time, it has occurred to me that a descriptive catalogue of our Lepidoptera might be useful to others, while it would serve to confirm the names given to these insects in my cabinet, and transmitted in return for specimens to my friends. My own collection has now become quite extensive, and contains a large number of undescribed species from various parts of the United States. Passing by our Butterflies, nearly all of which have been

figured and for the most part described in Dr. Boisduval's "Histoire et Iconographie des Lepidoptères de l'Amérique Septentrionale," I propose, at the present time, to offer for publication descriptions of the native insects in my collection belonging to the second grand division of the order Lepidoptera, comprising the Sphinges of Linnæus. Should these be favorably received, they may hereafter be followed by descriptions of our Phalænæ or moths. The larvæ or caterpillars of many of the species are described partly from my own observations, and partly from the figures given by Mr. Abbot in his great work, on the Lepidoptera of Georgia, edited by Sir James E. Smith. My obligations to the gentlemen who have favored me with specimens will be found recorded on almost every page of this catalogue, and I beg leave to tender to them my most grateful acknowledgments, and to solicit from them, and from others, a continuation of similar favors.

Linnæus was led to give the name of Sphinx to the insects in his second group of the Lepidoptera, from a fancied resemblance which some of their larvæ, when at rest, have to the Sphinx of the Egyptians. The attitude of these larvæ is indeed very remarkable. Supporting themselves by their four or six hind-legs, they elevate the fore-part of the body, and remain immovably fixed in this posture for hours together. In the winged state the true Sphinges are known by the name of humming-bird moths, from the sound which they make in flying, and hawk-moths, from their habit of hovering in the air while taking their food. These humming-bird or hawk-moths may be seen during the morning and evening twilight flying with great swiftness from flower to flower. Their wings are long, narrow, and pointed, and are moved by powerful muscles, to accommodate which their bodies are very thick and robust. They delight most in the honeysuckle and scarlet Bignonia, from the tubular blossoms of which they extract the honey, while on the wing, by means of their excessively long maxillæ or tongue. Other Sphinges fly during the day-time only, and in the bright sunshine. Then it is that our large clear-winged Sesiæ make their appearance among the flowers, and regale themselves with their sweets. The fragrant Phlox is their especial favorite. From their size and form and fan-like tails, from their brilliant colors, the swiftness of their flight, and the manner in which they take their food, poised upon

rapidly vibrating wings above the blossoms, they might readily be mistaken for humming-birds. The Ægeriæ are also diurnal in their habits. Their flight is swift, but not prolonged, and they usually alight while feeding. In form and color they so much resemble bees and wasps as hardly to be distinguished from them. The Smerinthi are heavy and sluggish in their motions. They fly only during the night, and apparently take no food in the winged state, their maxillæ or tongues being so short as to be useless for this purpose. The Glaucopididæ, or Sphinges with feathered antennæ, fly mostly by day, and alight to take their food like the Ægeriæ, to which some of them bear a resemblance, while others have nearly the form of Phalænæ or moths, with which also they agree in their previous transformations.

SYNOPSIS OF THE FAMILIES AND GENERA.

It was not my intention originally to give here the characters of the genera, but to refer the student for them to the works of Latreille and other entomologists. Upon further consideration, however, I have thought that the labor of determining our Sphinges by means of the catalogue would be much abridged, if a synopsis of the families and genera were to be prefixed to it.

Class Insecta.

Animals with jointed bodies, breathing through lateral holes or spiracles, produced from eggs; while growing subject to a transformation of three stages; in the first stage called larvæ, caterpillars, grubs, or maggots; in the second pupæ, nymphs, or chrysalids; in the third stage provided with wings, a body composed of three distinct parts, the head, thorax or trunk, and the abdomen, and having two compound eyes, two antennæ, from two to six palpi or feelers, and six legs.

Order Lepidoptera.

The young, called larvæ or caterpillars, are provided with jaws, and from ten to sixteen legs. They feed principally upon vegetable substances. The pupæ take no food, are incapable of moving about, are apparently without legs, these parts with their other members being folded up and firmly soldered to the body. In the third stage they are, with few exceptions, provided with four wings, which, with the body, are more or less covered with little colored branny scales, lapping over each other like the scales of fishes; their jaws are transformed to a tongue, more or less long, and, when not in use, spirally rolled and concealed between the palpi.

Section I.—Papiliones.

Antennæ threadlike and knobbed or thickened at the end. Wings not confined by a bristle and hook; all of them, or the first pair at least, elevated perpendicu-

larly, and turned back to back when at rest. Only one pair of spurs to the hind-legs in the greater number. Thorax moderate; abdomen rather slender. Flight diurnal. Larvæ with sixteen feet; transformation in the open air. Pupæ angulated, and fastened by silken threads, or ovoid, and enclosed in an imperfect cocoon.

Section II.—Sphinges.

Antennæ thickened in or just beyond the middle, tapering at each end, and most often hooked at the tip; more rarely slender and nearly setaceous, with a double row of slender teeth or hairs on the under side in the males. Wings confined by a bristle or bunch of stiff hairs on the front edge near the shoulder of each hind-wing, which is retained by a hook on the under side of each fore-wing; when at rest horizontal, or inclined on the sides of the body, the fore-wings covering and concealing the hind pair. Two pairs of spurs to the hind-legs. Thorax thick and robust; abdomen mostly conical. Flight of some in the morning and evening twilight, of a few nocturnal, and of others during the day. Larvæ with sixteen legs; transformation in or upon the ground, or in a silken cocoon. Pupæ elongated ovoid.

Section III.—Phalænæ.

Antennæ (never knobbed at the end or thickened in the middle) slender and tapering to a point, in some pectinated or feathered, in others simple or bristle-formed. Wings confined together by bristles and hooks, the first pair covering the hind-wings and horizontal or sloping when at rest. Two pairs of spurs to the hind-legs. Flight for the most part nocturnal. Larvæ with from ten to sixteen legs, transforming in a silken cocoon or in the ground. Pupæ ovoid.

The Sphinges may be divided into two tribes.

Tribe I.—Sphinges legitimæ.

Larvæ colored, naked, for the most part horned on the tail, and feeding on the leaves of plants; or whitish, slightly hairy, not horned, and living on woody matter within the stems of plants. Antennæ of the winged insects tipped with a minute bristly tuft.* Palpi (except in the Ægeriadæ) with the third joint minute and indistinct.

Tribe II.—Sphinges adscitæ.

Larvæ always colored, more or less hairy, never horned, feeding on leaves, and transforming in a silken cocoon, which is fastened to the plants on which they live. Antennæ of the winged insects not tufted at the end. Palpi distinctly three-jointed.

The first tribe, or Sphinges legitimæ, may be divided into three families.

Family I.—Sphingiadæ.

Antennæ fusiform and prismatic; ending in a hook, and, in the males, transversely biciliated beneath; or, more rarely, curved, and, in the males, bipectina-

* This little tuft is obsolete or wanting in the *Smerinthi.*

ted beneath. Palpi pressed close to the face, short, thick, and obtuse, with the third joint minute and concealed. Body thick; abdomen conical and not tufted at the end. Flight crepuscular. Larvæ colored, naked, with a caudal horn, which is sometimes obsolete and replaced by a callous spot; they devour the leaves of plants, and go deep into the earth to transform, or conceal themselves upon the surface, under leaves, in an imperfect cocoon.

The North American genera in this family are six.

Genus I.—Smerinthus.

Wings more or less angular and indented, the front margin of the hind-wings projecting beyond the upper or fore-wings when at rest. Antennæ short, prismatical and fusiform, arcuated or curved near the tip, transversely biciliated or bipectinated beneath in the males. Tongue obsolete. Larvæ granulated, with the head triangular, horned on the tail, obliquely banded on each side, and transforming in the earth.

Genus II.—Ceratomia.

Wings entire. Antennæ elongated, abruptly ending in a short and slender hook, transversely biciliated beneath in the males. Palpi horizontal and nearly cylindrical. Tongue moderate. Abdomen longitudinally striped. Larvæ with horns on the fore-part of the body, a row of little teeth on the back, a long caudal horn, and oblique bands on each side; it transforms in the earth.

Genus III.—Sphinx.

Wings entire. Antennæ long, abruptly ending in a short and slender hook, and transversely biciliated beneath in the males. Palpi rising and enlarged at the end. Tongue long. Abdomen spotted or transversely banded at the sides. Larvæ with oblique bands on the sides and a caudal horn, and transforming in the earth.

Genus IV.—Philampelus.

Wings sinous. Antennæ long, attenuated at the end, with a long terminal hook, and transversely biciliated beneath in the males. Tongue moderate. Abdomen not transversely banded or spotted at the sides. Larva short, thick, with the head and first three segments rather small and capable of being drawn more or less within the fourth segment; when young with a long, slender, recurved caudal horn, which subsequently disappears and is replaced by a callous spot; sides with oblique spots sloping backwards and downwards; transforms in the earth.

Genus V.—Chœrocampa.

Wings sinous or angulated. Antennæ rather short and slender, generally arcuated, tapering, and ending in a long hook; more rarely straight, with a short terminal hook; transversely biciliated beneath in the males. Tongue moderate. Abdomen immaculate, or longitudinally striped, but never transversely banded at the sides. Larvæ elongated, the fore-part of the body tapering and retractile; with from one to three eye-like spots, or a series of oblique bands on each side; caudal horn short, sometimes obsolete and replaced by a callous spot; transforms on the surface of the ground, under leaves, in an imperfect cocoon.

Genus VI.—Deilephila.

Wings entire, upper ones acute. Antennæ rather short, straight, gradually thickening nearly to the end, which suddenly terminates in a small and short hook; in the males transversely biciliated beneath. Tongue moderate. Abdomen conical, pointed, and transversely banded at the sides. Larva elongated, not tapering before, and the head and first three segments not retractile, with a series of nine or ten round spots on each side, and a long caudal horn; transforms in the earth.

Family II.—Macroglossiadæ.

Antennæ fusiform, prismatic, ending with a hook, and transversely biciliated beneath in the males. Palpi pressed close to the face, with the third joint minute and concealed; short, thick, and obtuse at the end in some; slightly elongated and subacute in others. Body short and thick, or flattened a little; abdomen tufted at the end. Flight diurnal. Larvæ colored, naked, with a caudal horn, which is sometimes obsolete and replaced by a callous spot; they devour the leaves of plants, and enter the earth to transform, or conceal themselves upon the surface in an imperfect cocoon under leaves.

In this family we have three genera, Pterogon, Thyreus, and Sesia.

Genus VII.—Pterogon.

Wings angulated and indented. Antennæ long, arcuated, tapering at the end, with a long, terminal hook. ——— Tongue as long as the body. Abdomen short and conical. Larvæ attenuated before, with a series of spots, on each side, sloping obliquely backwards and downwards, and a caudal horn, which is frequently obsolete and replaced by a callous spot: they transform in an imperfect cocoon under leaves.

Genus VIII.—Thyreus.

Wings angulated and indented. Antennæ long, and ending with a long hook. Palpi short, thick, and obtuse at the end. Tongue moderate. Abdomen ovoid. Larvæ elongated, not attenuated before, longitudinally striped on the back, obliquely banded at the sides, with a long and straight caudal horn: they transform in the earth.

Genus IX.—Sesia.

Wings entire, upper ones acute, all of them transparent in the middle. Antennæ short, straight, gradually thickened towards the end, with the terminal hook obsolete, and obliquely biciliated beneath in the males. Palpi somewhat elongated, subacute, and forming a conical beak. Tongue long. Abdomen short ovoid, slightly flattened. Larvæ not attenuated before, longitudinally striped on the back, with a short, slightly recurved caudal horn: they transform in an imperfect cocoon under leaves on the surface of the ground.

Family III.—Ægeriadæ.

Antennæ arcuated; either thickening to beyond the middle, attenuated and curved but not hooked at the end, and biciliated beneath in the males; or very slightly fusiform and almost threadlike, and simple in both sexes. Palpi elongated, slender, distinctly three-jointed, prominent, separated and not pressed close to the head, nearly cylindrical, covered with very small scales and almost naked ex-

cept at the base, which is hairy, and pointed at the tip. Wings more or less transparent. Abdomen with a caudal tuft. Flight diurnal. Larvæ whitish, soft, slightly downy, living within the stems of plants, and generally transforming in a cocoon made of fragments of wood and bark cemented by a gummy matter. Pupæ with the edges of the abdominal segments armed with transverse rows of small teeth.

The American species in this family may be disposed in the genera Trochilium, Ægeria, and Thyris.

Genus X.—Trochilium.

Wings narrow, entire, all of them, or the hind-pair at least, transparent. Antennæ short, stout, arcuated, gradually thickened nearly to the end, which is curved but not hooked; underside generally fringed with a double row of very short bristles in the males. Tongue very short. Body thick; abdomen slightly tufted at the end.

Genus XI.—Ægeria.

Wings narrow, entire, all of them, or the hind-pair at least, transparent. Antennæ mostly elongated, sometimes short, arcuated, gradually thickened nearly to the end, which is curved but not hooked; underside generally fringed with a double row of short bristles in the males. Tongue long. Body slender; abdomen nearly or quite cylindrical, ending with a flat or trilobed tuft.

Genus XII.—Thyris.

Wings broad, subtriangular, more or less angulated and indented, opaque, with small semitransparent spots. Antennæ fusiform, but slender and only slightly thickened in the middle, arcuated, and simple in both sexes. Tongue moderate. Body short and thick; abdomen conical, and tufted at the end.

Tribe II.—Sphinges adscitæ.

The species described in this catalogue may be disposed in three families, Agaristiadæ, Zygæniadæ, and Glaucopididæ.

Family IV.—Agaristiadæ.

Antennæ straight, slightly thickened in or beyond the middle, and curved at the tip. Palpi elongated, slender, not pressed to the face, hairy at base, with the terminal joint cylindrical, scaly or almost naked. Wings broad, subtriangular. Tail hairy or tufted. Flight diurnal. Larvæ elongated, cylindrical, or enlarged a little behind, slightly hairy, transversely banded or spotted, and without a caudal horn.

Genus XIII.—Alypia.

Wings broad, subtriangular, entire, and opaque, with large whitish spots. Antennæ somewhat elongated and slender, thickened very gradually from beyond the middle nearly to the tip, which is slightly curved, obtuse, and not tufted. Palpi long, porrect, separate, with the first two joints very hairy, and the third joint cylindrical, scaly, and obtuse. Tongue moderate, and spirally rolled. Abdomen somewhat elongated, nearly cylindrical, fringed at the sides and tip with short hairs. Anterior and intermediate tibiæ thickly clothed with hairs. Posterior tibiæ with two pairs of pretty long unequal spurs.

Family V.—Zygæniadæ.

Antennæ arcuated, abruptly thickened and curved beyond the middle. Palpi generally elongated, sometimes short, not pressed to the face, hairy at base, with the terminal joint scaly or almost naked. Wings narrow, opaque, often spotted, the hind-pair rather small. Abdomen more or less cylindrical, obtuse, and not tufted at the end. Flight diurnal. Larvæ short, contracted, variegated with spots, slightly hairy, and not horned on the tail.

Genus XIV.—Mastigocera.

Wings long, narrow, entire, opaque, the hind-pair quite small. Antennæ simple in both sexes, filiform at base, suddenly thickened and fusiform beyond the middle, very much attenuated towards the tip, and ending in a long curved point. Labial palpi somewhat curved, extending considerably beyond the clypeus, separated, well covered with hairs beneath the base; the penultimate joint longest, cylindrical, and scaly; the last joint also cylindrical, obtusely rounded at the end, and covered with small, close scales. Maxillæ (tongue) nearly as long as the body. Abdomen nearly cylindrical, obtusely rounded at the end, longitudinally grooved at the sides before, with the basal segment strongly marked, and swelling on each side into a little tubercle. Legs long and slender; posterior tarsi laterally compressed, and hairy on the outside, in the males.

Family VI.—Glaucopididæ.

Antennæ slender, almost setaceous, or very slightly thickened in the middle, and distinctly bipectinated beneath in the males. Palpi slender, more or less elongated, not pressed to the face. Wings sometimes narrow, and sometimes widened, entire, and for the most part opaque. Abdomen nearly cylindrical, and frequently tufted at the end. Flight diurnal. Larvæ cylindrical, hairy, without a caudal horn.

Genus XV.—Procris.

Wings narrow, elongated, opaque, and immaculate. Antennæ slender, tapering at each end, and bipectinated beneath in the males. Palpi small, short, pendent, and nearly naked. Tongue short, but distinct, and spirally rolled. Abdomen slender and nearly cylindrical in the males, thicker in the females, and tufted at the end. Spurs of the hind tibiæ two in number, and very minute.

Genus XVI.—Glaucopis.

Wings narrow in some, broad in others, entire, for the most part opaque, and with the body more or less glossed with blue, sometimes spotted or partially transparent. Antennæ feathered or bipectinated in both sexes, the pectinations elongated in the males, and short in the females. Palpi more or less elongated and recurved. Tongue moderate, spirally rolled. Caudal tuft minute or wanting in the greater number. Posterior tibiæ with three or four spurs of moderate size.

From this Synopsis it will be seen that the divisions and arrangement which I have adopted, differ somewhat from those of the entomologists of the present time. The affinities or resemblances of the Lepidoptera, in their different states, are so various, that it is impossible to preserve a natural connection between them in a linear series. After repeated trials, I have concluded still to adhere to the views of our great masters in Entomology, Linnæus and Fabricius, especially as modern entomologists are by no means agreed upon the limits of the larger divisions of the Lepidoptera, and the order of the genera.

ORDER LEPIDOPTERA. L.

SPHINGES. L.

Crepuscularia. Latr. *Clostérocères.* Duméril. *Hétérocères.* Boisduval. (Part.)

Tribe I. SPHINGES LEGITIMÆ. L.

Family I. SPHINGIADÆ. H. *The Sphingians.*

§ *Alis angulatis.* L.

Genus I. Smerinthus. Latr.

* *Antennæ transversely biciliated beneath in the males.*

1. *S. excæcata.* Smith–Abbot.

Fawn-colored; fore-wings deeply scalloped and toothed on the outer edge, clouded and banded with brown; hind-wings rose-colored in the middle, with a large round eye-like black spot, having a pale blue centre, near the anal angle; fringes narrow, white; thorax with a central lance-shaped chestnut-colored spot, the point of which extends upon the head. Expands two and a half to three inches and a half. *Larva* granulated, apple-green, with two short pale lines before, seven oblique yellowish white lines on each side, and a bluish caudal horn. It feeds upon the leaves of the apple-tree, and upon those of *Rosa Carolina* also, according to Abbot, who (in his Insects of Georgia, p. 49, pl. 25,) has represented a variety of the larva of a yellow color, and greenish at the sides, which are obliquely banded with yellow, and have two longitudinal rows of rust-red spots upon them. It enters the earth to undergo its transformations. *Pupa* chestnut-brown, with a short obtuse anal spine.

2. *S. Astylus.* Drury. = *integerrima.* H. Catalogue Ins. Mass.*

Cinnamon-colored; fore-wings angulated but entire, tinged with rosy white at base, with whitish wavy bands near the tip, a bluish mark along the inner margin, and a tawny yellow spot on each outer angle; hind-wings tawny yellow at base, with a round black eye-like spot, having a pale blue centre, near the anal angle; middle of the thorax cinnamon-red, shoulder-covers paler

* Catalogue of the Insects of Massachusetts, by T. W. Harris; appended to Prof. Hitchcock's Report on the Geology, &c. of Massachusetts.

with a rosy white tinge, and a brown edge above; abdomen with a longitudinal dorsal brown line. Expands from two and a half to two inches and three quarters.

My specimens, a male and a female, were captured at Cambridge on the *Azalea viscosa.*

3. *S. Myops.* Smith–Abbot. = *Rosacearum.* Boisd.

Chocolate-brown; fore-wings sinuated and angulated on the outer edge, varied with wavy whitish and brown bands, with a white Z at tip, and a tawny yellow spot on each of the outer angles; hind-wings with abbreviated whitish and brown bands upon the front edge, ochre-yellow next to the body, with a round black eye-spot having a pale blue centre near the anal angle; head and shoulder-covers glossed with bluish white; a rusty brown stripe in the middle of the thorax; abdomen with a few tawny yellow spots on each side. Expands from two inches and three lines to two inches and six lines. *Larva*, as figured by Abbot, (Ins. Georg. p. 51, pl. 26,) apple-green, the head margined with yellow, and two rows of rust-red spots with six oblique yellowish bands on each side of the body. Abbot says that it eats the leaves of the wild cherry-tree, and buries itself in the ground to undergo its transformations. *Pupa* deep brown.

M. Boisduval has named and figured but has not described this species, in the first volume of his Species Général des Lepidoptères, pl. 15, fig. 4; moreover the name given by him is subsequent to that of Sir J. E. Smith, which is an additional reason why it cannot be adopted.

* * *Antennæ pectinated on both sides in the males.*

4. *S. geminata.* Say.

Rosy ash-gray; fore-wings angulated and with a sinuous outer margin, varied with transverse wavy rosy gray and brown lines, a brown spot and angulated band near the middle, and a deep brown semioval spot at tip; hind-wings rose-colored in the middle, with a large semioval black spot including two pale blue spots near the anal angle; thorax with a large central semioval brown spot. Expands from two and a quarter to more than two inches and a half.

I am indebted to the Rev. L. W. Leonard, of Dublin, N. H., for my specimens, both of which are males. The figure of *S. ocellatus Jamaicensis*, in Drury's Illustrations, Vol. II, pl. 25, fig. 2, 3, very nearly resembles the *geminata*, but it has only one blue pupil in the eye-spot of the hind-wings. Mr. Kirby's *S. Cerisii*,

(Faun. Bor. Amer. IV, p. 301, pl. 4, fig. 4,) is probably identical with Drury's species.

* * * *Antennæ, in the males, with the joints distinct and doubly bipectinated.*

5. *S. Juglandis.* Smith–Abbot.

Rosy gray, drab, or dusky brown; wings indented on the outer edges; fore-wings with a dusky outer margin, a short brownish dash near the middle, and four transverse brown lines converging behind and enclosing a square dark brown spot adjacent to the middle of the inner margin; hind wings with two narrow transverse brown lines between two brownish bands; thorax with a central brown line; abdominal segments plaited and prominent at the sides. Expands from two and a quarter to three inches. The females are much larger and of a lighter brownish gray color than the males, with the square spot on the fore-wings less distinct. *Larva* with the head small, and the body attenuated before and behind, pale blue-green, with a long caudal horn, and seven oblique white bands on each side. When disturbed it makes a creaking noise by rubbing together the joints of the fore-part of its body. It eats the leaves of the black walnut, and enters the earth to undergo its transformations. Mr. Abbot (Ins. Georg. p. 57, pl. 29) has figured a remarkable variety of the larva, which is of a crimson color, with the fore-part of the body and the oblique bands yellow. *Pupa* deep chestnut-brown, granulated, with six little tubercles on the head-case, a transverse row of acuminated granules on the hinder edges of the abdominal segments, the last three of which segments are flattened beneath and angularly dilated at the sides, with the tip broad, truncated, and externally bidentate.

The antennæ of the males of this species differ from those of the preceding in having the joints distinct to the naked eye, and each joint furnished with two teeth or short pectinations on each side. Mr. Doubleday presented me with specimens, from Florida, which differ from our northern specimens only in being of a darker color.

* * * * *Antennæ, in the males,* ———.

6. *S. modesta.* H.

Drab-colored; fore-wings scalloped, with a transverse dusky band before the middle; hind-wings purplish-red in the middle, deeper red next to the base, and with a blackish spot near the anal angle. Expands four inches and one quarter.

I have never seen but one specimen, which was much rubbed before it came into my possession. It is a female, with a very thick and robust body, and simple antennæ, and probably is the North American representative of *S. Tiliæ* and *Quercus*.

§ *Alis integris, ano simplici.* L.

Genus II. Ceratomia. H.

I have been induced to propose a new genus for the reception of a single species, presenting characters, in the larva and winged state, which do not allow it to be included in the genus Sphinx as now received. The larva of this species, in the possession of horns on the fore-part of the body, exhibits a peculiarity which hitherto appears to have been unnoticed or undescribed among the Sphinges. The name of the genus, derived from κέρατα, *horns*, and ὦμια, *the shoulder*, alludes to this peculiarity. An analogous and still more imposing form is found in the larvæ of the *Phalænæ*, belonging to the genus *Ceratocampa*.

C. quadricornis. H.

Light brown; fore-wings with zigzag and wavy brown and whitish bands, dusky in the middle to the inner margin, the anterior edge whitish, and a large white dot near the middle; hind-wings with three dusky transverse bands, and a broad blackish hind-border; fringes dotted with white; head and a broad line on each side of the thorax to the shoulders white; shoulder-covers with three and abdomen with five longitudinal brown lines. Expands four and a half to nearly five inches. *Larva* pale blue-green, longitudinally wrinkled, with a pair of short denticulated horns on the second segment, a similar pair on the third, two parallel series of little teeth on the first four segments, a dorsal row of larger teeth extending to the tail, a long bluish caudal horn, and seven narrow oblique white lines on each side of the body. It feeds upon the leaves of *Ulmus Americana*, and transforms in the earth.

Genus III. Sphinx. L.

* *Tongue-case of the pupa detached from the breast.*

1. *S. cingulata.* F. = *Convolvuli.* Smith–Abbot.

Dark ash-gray, variegated with brown, body beneath white; middle of the hind-wings pink, with three or four black bands; fringes of the wings spotted with white; and five pink-colored spots separated by short transverse black lines on each side of

the abdomen. Expands about four inches. Larva, as represented by Abbot, (Ins. Geog. p. 63, pl. 32) dark brown, with a double chain-like rust-red dorsal line, a paler lateral line, a series of eight hook-shaped yellowish spots on each side enclosing the spiracles, and a short curved horn on the tail. Eats the leaves of the sweet potato (*Convolvulus batatas*,) and enters the earth to undergo its transformation. *Pupa* with a long hooked tongue-case spirally recurved at its extremity. Inhabits the Middle and Southern States.

I am indebted to Dr. J. E. Holbrook, of Charleston, S. C., for a specimen.

2. *S. Carolina.* L.

Ash-gray; fore-wings with blackish wavy lines; hind-wings whitish in the middle, with four black bands, the two central ones narrow and jagged; fringes spotted with white; five orange-colored spots encircled with black on each side of the abdomen; and the tongue excessively long. Expands about five inches. *Larva* apple-green, transversely wrinkled, with seven oblique white lines on each side, and a rust-colored caudal horn. Commonly known by the names of *potato-worm* and *tobacco-worm*, from the plants on which it is found; transforms deep in the earth. *Pupa* with a long tongue-case, curved near the head, straight and touching the breast only at the end, representing the handle of a vase.

3. *S. Drupiferarum.* Smith–Abbot.

Pale reddish-gray; fore-wings with a dark brown band extending from the inner margin to the tip, and crossed by slender black lines between the nervures;* hind-wings with two transverse blackish bands; thorax dark chestnut, with the sides and the head white; abdomen dark brown above, with a slender dorsal black line and about five whitish lateral spots margined with black. Expands three and a half to four inches. *Larva*, according to Abbot, (Ins. Geog. p. 71, pl. 36) apple-green, with seven oblique lateral bands, which are violet above and white below, a line on each side of the head and the caudal horn violet. Feeds on the leaves of the *Celtis* and plum, and is transformed in the earth. *Pupa*, like that of *S. Ligustri*, with a short tongue-case detached from the breast.

* The veins, or elevated and branching lines on the wings of insects, are called *nervures* by Mr. Kirby.

4. *S. Kalmiæ.* Smith–Abbot.

Rusty-buff; fore-wings streaked with light brown, and with a narrow whitish band near the outer margin; hind-wings with a narrow central and a broad marginal blackish band; fringes brown spotted with white; shoulder-covers white edged with brown; abdomen with a slender dorsal black line and short transverse bands alternately black and white at the sides; beneath dull reddish white. Expands three and a half to four and a quarter inches. *Larva*, according to Abbot, (Ins. Georg. p. 73, pl. 37) pale green, with seven oblique yellow bands, edged above with violet, on each side, the caudal horn and a line on each side of the head blue, and the hinder pair of legs yellow. Feeds on the leaves of *Kalmia latifolia*, and transforms in the earth. *Pupa* with a short detached tongue-case.

5. *S. Gordius.* Cramer.

Brownish ash-gray; fore-wings streaked with black between the nervures, with the anterior and inner margin dusky-brown, a white dot near the middle, and a large gray spot at base; fringe spotted with white; hind-wings with a narrow central and a broad marginal dusky brown band, and a white fringe; thorax deep chestnut, with the sides and the head above whitish; abdomen with a central black line, and the sides ash-white transversely banded with black. Expands three to three inches and a half. *Larva* apple-green, with seven oblique white lateral bands, slightly edged above with violet, a rust-red caudal horn, and a brownish line on each side of the head. It lives on the apple-tree, and enters the earth to be transformed. *Pupa* with a very short detached tongue-case.

6. *S. cinerea.* H.

Ash-gray; fore-wings long, narrow, and entire, with five short oblique lines between the nervures; hind-wings with two blackish bands; shoulder-covers slightly edged with black above; abdomen with a narrow dorsal black line, and short alternate bands of black and dirty white on the sides. Expands four and a half to five inches and a quarter.

The specimens from which this description is taken were raised many years ago from larvæ, which, at the time, I neglected to figure and describe. To the best of my recollection, these larvæ were found on the lilac, and, with the pupæ, corresponded very nearly in form, color, and size, to those of the European *S.*

Ligustri. The present species is remarkable for the length and sharpness of the wings, which are of a fine neutral gray tint, and for the prominence of the head and palpi.

* * *Tongue-case of the pupa not detached, but buried, and soldered to the breast.*

7. *S. sordida.* H.

Dark gray; fore-wings variegated with dark brown, dashed with a few blackish lines, and with a whitish dot near the middle; hind-wings with a blackish basal spot, and two broad black bands; a dark brown line on each shoulder-cover; abdomen with a dorsal black line, and alternate black and light gray bands on the sides. Expands two inches and three quarters.

Although the larva and pupa of this species are unknown to me, I judge from analogy that it belongs to this division of the genus Sphinx.

8. *S. Hylæus.* Drury. = *Prini.* Smith–Abbot.

Rusty brown; fore-wings mottled with white, banded with jagged dark brown lines, with a white dot near the middle, and a spot of the same color at tip; hind-wings whitish with a narrow indented brown band across the middle, and a broad one on the outer margin; fringes spotted with white; a whitish line above the eyes extending on each side of the thorax; two longitudinal rows of white dots on the top of the abdomen, and a series of short narrow white bands on each side. Expands two and a quarter to two inches and three quarters. *Larva* pea-green, with six or seven oblique lateral whitish bands edged above with pink, a purple caudal horn, and a pale blue line on each side of the head. It feeds on the leaves of *Prinos glaber* and various species of *Vaccinium*, and enters the earth to be transformed.

This insect is much like the *Brontes* of Drury, which, however, is a much larger species, more distinctly banded with white, &c.

9. *S. Plebeja.* F.

Gray; fore-wings with a white dot near the middle, and five or six short oblique blackish lines between the nervures; hind-wings sooty black, dirty white at base; fringes white, spotted with dark brown; abdomen with three black lines, one dorsal, and two on each side, the latter enclosing a longitudinal series of dirty white spots. Expands three inches. Inhabits the Southern States.

The only specimen which I have seen was taken by Prof. Hentz in North Carolina, and now belongs to the Boston Society of Natural History.

10. *S. Coniferarum.* Smith–Abbot.

Gray; fore-wings with about three narrow and indented brownish bands, a spot near the middle, one or two streaks beyond the middle, and the nervures near the outer margin brown; hind-wings dusky or blackish gradually fading into gray towards the base; fringes spotted with brown and white; abdomen gray with brownish incisures. Expands one inch and three quarters to two inches and three quarters. *Larva*, as figured by Abbot, (Ins. Georg. p. 83, pl. 42,) chequered with brown and white spots, with a dorsal whitish line, and a short caudal horn. It eats the leaves of various kinds of pine, and enters the earth to transform. Mr. Leonard informs me that the tongue-case of the *Pupa* is short, and buried so as not to rise above the leg-cases.

For my specimen I am indebted to the Rev. L. W. Leonard, who raised it from a larva found on the pine in Burlington, Vt. In the cabinet of the Boston Society of Natural History there is a larger specimen, which was taken in North Carolina by Prof. Hentz; the bands on the wings in the latter are less distinct than in my specimen.

11. *S. Ello.* L.

Gray; fore-wings slightly indented on the outer margin, with a few irregularly scattered black dots, and a blackish stripe extending from the base to the tip; hind-wings rust-red, with a broad black hind-border; thorax with five longitudinal black lines, and abdomen on each side banded with black. In the female the blackish stripe on the fore-wings and the lines on the thorax are usually wanting or indistinct. Expands three and a quarter to four inches. Inhabits the Southern States, the West Indies, and South America.

In the cabinet of the Boston Society of Natural History there is a specimen of this tropical insect, which was captured by Prof. Hentz in the interior of North Carolina, where eventually the species may become common. According to Madam Merian (Insectes de Surinam, page and plate 61) the *larva*, in Surinam, lives on the leaves of a species of *Psidium* or Guava, is of an obscure brown color, with a black dorsal line, some small irregular white spots on the sides, and the head and caudal horn purple.

The tongue-case of the *pupa*, from the figure, seems to be short and soldered to the breast. From the shape of its body and wings, this insect must belong to a very distinct group in the Linnean genus Sphinx; but, without knowing more of the larva and its transformations, I do not feel authorized to separate it from the present genus.

Genus IV. PHILAMPELUS. H.

The insects belonging to this genus cannot with propriety be included in the genus *Chœrocampa* of Duponchel, or *Metopsilus* of Duncan, to which they approach the nearest; and, therefore, I have considered it proper to institute a new genus for their reception. They, indeed, seem to form a characteristic and typical group, peculiar to the New World, being found only in the United States, Mexico, the West Indies, and the tropical parts of South America. The larvæ feed chiefly on the vine and the plants allied to it, which suggested the name of the genus, derived from φιλέω, *I love*, and ἄμπελος, *a grape-vine.* In those species whose transformations have passed under my own observation, the larvæ when young were furnished with a long slender caudal horn, recurved over the back like the tail of a dog; when about half grown, the caudal horn is shed with the skin, and is replaced by a prominent, eye-like, polished spot. The oblique spots on the sides of these larvæ slope downwards and backwards; this is also the direction of the bands in the larvæ of *Pterogon;* but in those of all the other *Sphinges* the oblique lateral bands slope upwards and backwards. The *pupa* is elongated, attenuated at the fore-part, with a pretty long, robust, rough, anal horn, notched at the tip; the tongue-case is buried and soldered to the breast, and slightly longer than the wing-cases; and the fore-part of the abdominal rings is roughened with deep punctures. In the perfect state, the fore-wings are entire, acute, slightly emarginated below the tip in the males, and almost falcated, with a sinous inner margin, and well-marked hind-angle; the outer margin of the hind-wings is undulated or slightly crenated; the shoulder-covers are large; and the abdomen is short, thick, conical, and usually immaculate. Madame Merian in her Insectes de Surinam, plates 34 and 47, has represented the transformations of three species of this genus; and two are also figured by Mr. Abbot in the Insects of Georgia, plates 40 and 41.

1. *P. Vitis.* L.

Grayish flesh-colored; fore-wings, except the anterior and outer margins, dark olive, with a broad stripe from base to tip, crossed by another from the middle of the inner margin, a small hook-shaped spot near the middle, and the nervures behind, of a pale flesh-color; hind-wings pale green at base, with the inner and hinder margins rose-red, a black spot near the middle and a black transverse band behind; a longitudinal line on the head and thorax, the shoulder-covers, two broad stripes on the abdomen, and a round spot on each side of its base of a dark olive color. Expands about four inches. Larva, as represented by Abbot, (Ins. Georg. p. 79, pl. 40,) pale pea-green, longitudinally striped on the top of the back and transversely at the sides with brown, and with seven oval, oblique, cream-colored spots on each side. According to Linnæus and Mad. Merian, it lives on the grape-vine; but Mr. Abbot has represented it upon *Jussiæa erecta.* Inhabits the Southern States, South America, &c.

This insect fades very much by age, which changes the flesh-colored portions to a pale reddish buff or nankin color. My specimens were received from Dr. J. E. Holbrook, of Charleston, S. Carolina.*

2. *P. Satellitia.* L. = *Licaon?* Cramer.

Light olive, variegated with dark olive; fore-wings with an abbreviated band beyond the middle, an oblong patch on the basal half of the hind margin including a square darker spot, a semi-oval spot near the tip, and a triangular one near the hind angle, of a dark olive color, and two approximated brownish dots near the middle; hind-wings with a black spot near the middle of the inner margin, and a transverse blackish band behind, obsolete near the anal angle and ending there in a few small black spots;

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* I have received from Dr. H. B. Hornbeck, King's physician, in the island of St. Thomas, W. I., a species which is closely allied to *P. Vitis;* and, as it is not described in any of my books, I am happy to describe it here under the name of

P. Hornbeckiana.

Above olive gray; fore-wings dark olive, with two silvery white stripes crossing each other in the middle of the wing, the longest stripe toothed near the base of the wing and obsolete thence to the middle, three of the nervures and a band on the outer margin whitish, and two approximated black dots near the middle; hind-wings on the inner margin pink, with a large square olive-colored spot, dusky behind with a black transverse band; an olive-colored line on the head and thorax; the shoulder-covers and first segment of the abdomen olive, bordered with white; upper part of the abdomen olive, with a central gray line; outer sides of the legs and antennæ white. Expands about four inches. Inhabits St. Thomas, W. I.

a slender line on the head and thorax, the shoulder-covers, and a transverse patch on the top of the first abdominal segment, dark olive. Expands from four to four inches and three quarters. *Larva*, when young, pea-green, with a slender recurved caudal horn, and of the same color or of a clear light brown and without a tail afterwards, with six oblique broad oval cream-colored spots on each side of the body; feeds on the leaves of indigenous and exotic grape-vines, and on those of *Ampelopsis hederacea*, and enters the earth to transform.

3. *P. Achemon.* Drury. = *Crantor?* F.

Red-ash colored; fore-wings with a few short transverse brown lines, and shaded with brown from the middle to the hind margin, with a square spot near the middle of the inner margin, another near the tip, and a triangular spot near the hind angle, of a deep brown color; hind-wings pink, with a deeper red spot near the inner margin, a dusky hind border, and a transverse row of small black spots; palpi and a large triangular spot on each shoulder-cover deep brown. Expands from three to four inches. *Larva* pea-green with a slender recurved tail when young, of the same color or light brown and without a tail subsequently, with six oblique oblong oval scalloped cream-colored spots on each side. It eats the leaves of grape-vines and of the common creeper or *Ampelopsis.*

This and the preceding species, in the larva state, are very injurious to our cultivated grape-vines.

Genus V. Chœrocampa. Duponchel.

Metopsilus. Duncan. *Deilephila.* (section.) Boisduval.

This genus was established, in 1835, by M. Duponchel,* to receive certain European Sphinges the larvæ of which have the head and fore-part of the body retractile, the head being very small, and the first three segments abruptly diminishing in size from the fourth, which gives to the fore-part of the body a resemblance to the head and snout of a hog. Hence the French name of these larvæ, *cochonnes*, and the generical name proposed by Duponchel, which is derived from χοῖρος, *a hog*, and κάμπη, *a caterpillar*. This peculiarity in the form of the larvæ seems to have suggested to Linnæus the names that he has given to two

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* Godart and Duponchel. Lepidoptères de France. Supplément. Tome II, p. 159. (1835.)

of the species, to wit, *porcellus*, *the pig*, and *Elpenor*, the name of one of the companions of Ulysses, who was changed to a hog by Circe. In the year 1836, Mr. Duncan,* probably not aware of the previous establishment of this genus, pointed out its characters under the name of *Metopsilus*, derived from *μέτωπον*, *the front*, and *ψιλὸς*, *slender*, in allusion to the form of this part of the larva. These naturalists, in separating this new group from the genus *Sphinx*, or rather from *Deilephila*, seem to have had only European insects under consideration; but in America there are several species, which, so far as similarity of form and habits, in all their states, indicates a natural affinity, ought certainly to be included in the same generical group, from which, however, they will be excluded unless the characters of the genus are somewhat modified to receive them. Believing the genus to be a good one, and susceptible of modification, I have changed the characters of it in the synopsis prefixed to this catalogue, so as to admit our American species. In *C. Pampinatrix*, *Chœrilus*, and *versicolor*, the antennæ are rather short and slender, arcuated, and end in a very long slender hook; the fore-wings have the outer and inner margins sinuous, so as to exhibit prominent outer and hinder angles; the hind-wings have a sinuous hind-margin, and a prominent angle near the tail; and the abdomen is rather short, and conical at tip. The *larvæ* of the first two of these species have the eleventh segment conically prolonged above, forming a base for a very short slightly curved caudal horn, and the sides of the body are marked with oblique bands sloping upwards and backwards. They transform above ground, under fallen leaves, or slightly covered with grains of earth, connected by a few threads, so as to form a loose imperfect cocoon. The pupa is short, thick, obtusely rounded before, with the tongue-case imbedded, indistinct, and nearly as long as the wing-cases; the tail is rather blunt, and ends in a long, slender point, which, under a magnifier, is found to be rough, and notched at the tip.

1. *C. Pampinatrix.* Smith–Abbot.

Light olive-gray above, shaded with olive; fore-wings with a dot near the middle, a transverse band near the base, a broader band beyond the middle and a large triangular spot adjacent to each acute angle and almost forming a third band, of an olive color; hind-wings rust-colored, dusky behind, and gray next the

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* Jardine's Naturalist's Library. Entomology. Vol. iv, p. 154. (1836.)

anal angle; head and shoulder-covers dark olive; and a white line on each side of the thorax at the origin of the wings. Expands two and a half to two inches and three quarters. *Larva* pale green, with a longitudinal series of six triangular orange-colored spots on the top of the back and a darker green lateral line; sides below this paler, almost white, sprinkled with rusty dots, and with six oblique green bands; caudal horn short, bluish green. It varies in being of a clear light brown color, with the back bounded on each side by a darker longitudinal line, meeting at the origin of the caudal horn, the sides tinged with pink, and obliquely banded with brown. Feeds on the leaves of the grape-vine. *Pupa* clay-colored, sprinkled and punctured with black, and with the incisures of the abdomen black.

Mr. Abbot, on plate 28 of his Insects of Georgia, has represented this larva with the caudal horn too long and too much curved, and the eleventh segment not so much produced behind as it ought to be. This species, in the winged state, comes very near to Cramer's *Sphinx Myron*, which, from the figure, seems to want the spot in the middle of the fore-wings, and, according to Cramer, has a very short tongue, a character that does not apply to the *Pampinatrix*. The larva, above described, is one of the most injurious to our cultivated grape-vines; for, not satisfied with devouring the leaves, it nips off the fruit-stalks when the grapes are not more than half grown. I have gathered under a single grape-vine above a quart of unripe grapes which had been detached thus during one night by these larvæ.

2. *C. Chœrilus*. Cramer. = *Azaleæ*. Smith–Abbot.

Rust-colored; fore-wings rusty gray tinged with blue, with a dot near the middle, a few spots between it and the base, and a very broad band beyond the middle, rust-colored; hind-wings rust-colored, dusky near the anal angle, with a whitish fringe; a spot at the sides and a slender line on the top of the thorax, the edges of the shoulder-covers and of the abdominal segments white. In the male the broad band of the fore-wings is marked by a pale and a dark zigzag line so as nearly to divide it into two bands. Expands two and a half to three inches. *Larva*, as represented by Abbot, (Ins. Georg. p. 53, pl. 27,) varying in color, being either pale green, with a narrow dusky dorsal line, a greenish line on each side, a blue-green caudal horn, and the sides obliquely banded with green; or clear pale red, with the lines and bands brownish, and the horn chestnut-colored. Mr. Abbot

says that it lives on *Azalea nudiflora,* and that it spins itself up in a thin web on the leaves. *Pupa* like that of *C. Pampinatrix.*

3. *C. versicolor.* H.

Light olive, variegated with olive-green and white; fore-wings with narrow curved bands of white and olive-green, and a zigzag white line at tip; hind-wings rust-colored, with the inner and hind margin olive-green; tips of the palpi, a line on each side of the head above the eyes, a longitudinal dorsal line from the front to the tail, and the edges of the collar and of the shoulder-covers, white; two spots on the metathorax and the abdominal segments on each side of the dorsal line tinged with dark buff. Expands about three inches.

Although the larva and pupa of this species are unknown to me, I have ventured to place it in the genus *Chærocampa.* The palpi are rather thicker towards the tip than those of the two preceding species; the fore-wings are not quite so much emarginated, and consequently, their angles are not quite so prominent. The under-side is quite as prettily variegated as the upper-side; that of the fore-wings being pale olive, tinged with deep buff near the hind-angle, with rust-red in the middle, and mottled and streaked with olive-green and white; that of the hind-wings olive-green, banded with white, dark olive, and buff. My specimen was taken sitting upon the leaves of *Azalea viscosa;* it was quite fresh, and seemed to have been recently transformed.

Dr. Hornbeck has presented to me a species, from St. Thomas, resembling the *versicolor* very nearly in color and form; but the palpi are more prominent, the antennæ are not so much arcuated, and the terminal hook is much shorter. It evidently leads to the genus *Deilephila.*

4. *C. tersa.* L.

Grayish olive above; fore-wings streaked from base to tip with numerous narrow dusky and pale lines, and with a minute black dot near the middle; hind-wings black, paler round the edges, with the anal angle and the fringe cream-colored, and a transverse row of small wedge-shaped cream-colored spots near the hind-margin; a reddish white line on the sides of the head and thorax; shoulder-covers slightly edged above with rust-red; sides of the abdomen, and the body and wings beneath, rusty buff, streaked and sprinkled with dusky olive-gray. Expands two and three quarters to three inches. *Larva,* according to Abbot, (Ins. Georg. p. 75, pl. 38,) pea-green or brown, with seven white eye-

like spots having a red centre and a black margin and connected by a longitudinal white line, on each side of the body, and a red caudal horn. It lives on *Spermacocce Hyssopifolia*, and, like the other species, is transformed in an imperfect cocoon which it spins above ground. *Pupa* clay-colored, freckled with dusky spots. It inhabits the Southern States, the West Indies, and South America.

I am indebted to Dr. J. E. Holbrook of Charleston, S. C., and to Dr. H. B. Hornbeck, of St. Thomas, W. I., for specimens. The antennæ are straight, with a shorter terminal hook than in the three preceding species; the outer margin of the fore-wings is not so sinuous, and the abdomen is much more elongated, slender and pointed. It may be necessary, hereafter, to institute a new genus for the reception of this and several other closely allied West-Indian and South-American species.

Genus VI. Deilephila. Ochsenheimer.

1. *D. lineata.* F. = *Daucus.* Cramer.

Olive-brown; fore-wings with a pale buff-colored stripe from the base of the inner margin to the tip, crossed by six white lines on the nervures, the outer margin ash-gray, the fringe and edge of the inner margin white; hind-wings rose-pink, with a white spot near the inner margin, a black band at base, another near the hind-margin, and the fringe, white; a white line on each side of the head above the eyes, and six lines, of the same color, placed in pairs, on the thorax; two rows of small black spots and a slender dorsal white line on the top of the abdomen, the sides reddish, with a short transverse black band on each side of the first abdominal segment, and a white band behind it, followed by a lateral series of alternately black and white spots. Expands from three to four inches. *Larva* pea-green, with a longitudinal series of nine or ten orange-colored oval spots encircled with black, on each side, and an orange-colored caudal horn. Feeds upon the leaves of the purslane and turnip, and of various other humble plants, and buries itself in the ground to undergo its transformations. *Pupa* light brown.

Contrary to what is usual among our Sphinges, there are two broods of this species in the course of one summer. This is the true *Sphinx lineata* of Fabricius, described by him as an American insect in his "Systema Entomologiæ." His description of the thorax, "*striis tribus albis duplicatis*," applies exactly to our insect, and not to the *Livornica* of Europe, with which it is often

confounded, and which has only four white lines instead of six, on the thorax. The larva of the latter, moreover, differs from that of our *lineata.* Dr. Hornbeck has sent to me from St. Thomas, W. I., specimens which vary a little, but are not specifically distinct from the *lineata* of the United States.

2. *D. Chamœnerii.* H. = *Epilobii.* H. (Catalogue.)

Olive-brown; fore-wings with a sinuous buff-colored stripe, indented before, beginning near the base of the inner margin and extending to the tip, and a dark olive-brown tapering stripe behind it, a black spot at base, a white dash and a diamond-shaped blackish spot before the middle; hind-wings dark brown, with a transverse rose-colored band, including a white spot near the body and a deep red one before the anal angle; inner edge of the fore-wings and fringe of the hind-wings whitish; palpi white below; a white line above each eye extending on the sides of the thorax, where it is bounded above by a black line; abdomen with a dorsal series of white dots, two black and two alternating white bands on each side of the base, and two narrow transverse white lateral lines near the tip; segments beneath edged with white. Expands from two and three quarters to three inches. *Larva* green, somewhat bronzed, dull red beneath; with nine round cream-colored spots, encircled with black, on each side, and a dull red caudal horn. It lives on the *Epilobium angustifolium*, and (as Mr. Leonard informs me) transforms in the ground, without making a cocoon. Inhabits New Hampshire.

The larva very closely resembles that of *D. Galii*, as figured by Roesel, III, Tab. VI, Fig. 1, 2. For a specimen of it, and for the insects in the winged state, I am indebted to Mr. Leonard, by whom they were raised. This species is the American representative of *D. Galii*, and is also allied to several other European species, such as *D. Epilobii*, *Esulæ*, *Amelia*, *Tithymali*, *Dahlii*, *Euphorbiæ*, &c.; but I am satisfied that it is perfectly distinct from all of them; and the long description which I have given of it will render it easy to discover in what respects it differs from them. Moreover it is a legitimate species, which is more than can be said of all of the above-named European insects, some of which are now admitted to be hybrids. Mr. Kirby (Fauna Boreali-Americana, IV, p. 302,) describes a North American species, under the name of *D. intermedia*, which, according to him, has the stripe on the fore-wings of a pale rose color, and wants the

dorsal series of white dots on the abdomen; in other respects it seems nearly allied to the *Chamænerii*. When my Catalogues of the Insects of Massachusetts were published I was not aware that the specific name *Epilobii* had been previously appropriated; for the species to which I then applied it I have now substituted that of *Chamænerii* derived from Tournefort's name for the genus *Epilobium*.

§ *Legitimæ* —— *ano barbato.* L.

Family II. MACROGLOSSIADÆ. H. *The Macroglossians.*

Sesiidæ. Stephens. *Sesiadæ.* Kirby.

* *Wings angulated and indented; antennæ tapering at the end, with a long terminal hook.*

Genus VII. Pterogon. Boisduval.

P? inscriptum. H.

Ash-gray; wings angularly indented; first pair with two dusky bands near the base, connected on the inner margin by a blackish line, a few undulated and zigzag transverse lines beyond the middle, a dusky outer margin, a half-oval brown spot at tip, and a small deep brown patch including a white I near the tip; hind-wings reddish gray, with a dusky hind-margin; collar edged with brown; abdomen with two dorsal series of black dots. Expands two inches. Inhabits Indiana.

Of this species I have seen only two individuals, both females, having rather long slender and simple antennæ, attenuated and curved so as to form a hook at the end. In the shape of the wings and distribution of the colors this insect nearly resembles some species of *Smerinthus*, from which genus it is excluded by the length of the tongue, which nearly equals that of the body. *Pterogon Gauræ*, which I suppose to be the only legitimate species of the genus that has yet been discovered in the United States, is known to me only by Mr. Abbot's figure.

Genus VIII. Thyreus. Swainson.

1. *T. lugubris.* L.

Brown; wings sinuated and slightly angulated on the outer edge; first pair with an oblique streak and an eye-like dot before

the middle, and a large triangular brown patch near the tip; hind-wings with two or three obscure transverse brown lines; male with a triple-tufted tail. Expands two and a half to three inches. Inhabits the Southern States. *Larva* pale green, with three darker longitudinal dorsal lines, nine oblique yellowish bands on each side, and a long, slender, nearly straight caudal horn. Mr. Abbot, from whose figure (Ins. Geog. p. 59, pl. 30) this description of the larva is taken, says that it feeds on Virginian creeper, *Ampelopsis Hederacea*, and that it enters the earth to transform. The *pupa* is elongated, chestnut-brown, with a short anal point.

My specimen of this insect was presented to me by Dr. J. E. Holbrook. It is closely allied to several South American species, figured by Cramer, such as his *Fegeus*, *Gorgon*, &c.; and, indeed, the *Fegeus* may prove to be identical with it.

M. Boisduval (Icones Hist. des Lépidoptères d'Europe nouveaux, Vol. II, p. 15) refers the *Gorgon* of Cramer [?] to his genus *Pterogon*; but, in my opinion, the genus *Thyreus* of Swainson, besides having the priority in point of time, is entitled to rank as a distinct genus. Is the European *Gorgon* of Esper, Hübner, and Ochsenheimer, quoted in Mr. Children's Abstract of the Characters of Ochsenheimer's Genera (Philos. Mag. N. S. Vol. V, p. 37), the same as the Surinam species named *Gorgon* by Cramer? And if not, is M. Boisduval's citation of Cramer's name correct?

2. *T. Abbotii.* = *Abbottii.* Swainson.

Chocolate-brown; wings very much indented on the outer edge; first pair with wavy and oblique blackish brown streaks, and a black dot near the middle; hind-wings yellow, with a broad blackish brown hind-border; edge of the collar and a transverse stripe across the thorax black; abdomen banded with black at base, tufted at the sides of the hinder segments, and terminated by a triple-tufted rust-colored tail. Expands from two and one third to nearly three inches. *Larva*, as figured by Abbot, (Swainson's Zoological Illustrations, Part I, pl. 60) pea-green, with narrow dorsal brown lines, nine lateral oblique yellowish bands broadly bordered above with brown, and a long slender slightly curved caudal horn. It feeds on the grape-vine. *Pupa* chestnut-brown, with two yellowish abdominal incisures.

This species is not uncommon in the Southern States, and I have one specimen which was taken in Cambridge, Mass.

3. *T? Nessus.* Cramer.

Dark brown; fore-wings with a sinuous and angular outer edge, a blackish brown band across the middle, another near the outer margin, and a small rust-red spot near the tip; hind-wings rust-red, with a dark brown hind-border; abdomen with two pale yellow bands behind the middle, four rust-red spots on each side, and a triple-tufted tail. Expands from two to two inches and a quarter.

Of this species I have seen only females, in which the antennæ are similar to those of the same sex in *T. Abbotii.* The palpi, however, are more acuminated, and approach in form to those of *Sesia Pelasgus*, &c. It ought, perhaps, to be included in a new genus, which, without a knowledge of the larva and pupa, I shall not venture to propose.

* * *Wings entire; antennæ thickened towards the end, with a minute terminal hook.*

Genus IX. Sesia. F. (Syst. Gloss.)

1. *S. Pelasgus.* Cramer.

Wings transparent and iridescent, with a broad purple-brown border and nervures; antennæ and palpi, above, blue-black; head and thorax olive; breast and legs cream-white; abdomen purple-brown below, ochre-yellow above, with the two middle segments and a spot behind them purple-brown, and three lateral white spots; tip with a central fan-shaped brown tail, and two black tufts on each side of it. Expands from two to two inches and one quarter.

2. *P. diffinis.* Boisduval. = *fuciformis.* Smith–Abbot.

Wings transparent and iridescent, with a narrow blackish border and nervures, and a rust-red spot at tip; antennæ and palpi black above; thorax and breast covered with pale yellow hairs; abdomen black above, with two longitudinal patches of yellow hairs, the two middle segments black, the next two covered with yellow hairs, and the tip with a fan-shaped tail, which is yellow in the middle and tufted with black on each side. Expands from one inch and three quarters to two inches. *Larva*, according to Abbot, (Ins. Georg. p. 85, pl. 43.) pale pea-green, reddish beneath, with a longitudinal dorsal line, a lateral pale yellow stripe, and a

short recurved caudal horn. In Georgia, it feeds upon the *Tabernæmontana Amsonia*, and forms an imperfect cocoon on the surface of the ground. *Pupa* brown with the abdominal incisures ochre-yellow.

My specimens were presented to me by Mr. Leonard, who captured them in New Hampshire, where the *Tabernæmontana* does not grow. The larva must, therefore, be sought upon some other plant; perhaps it may be found upon the *Apocynum.* M. Boisduval has named and given a figure of this species in his Hist. Nat. des Insectes Lépidoptères, Vol. I, pl. 15, fig. 2; and, as it is evidently distinct from the European *fuciformis*, I have retained the name proposed by M. Boisduval, although he has not established a claim to it by any description of the insect. Mr. Kirby's *S. ruficaudis* (Faun. Bor. Amer. IV, p. 303,) is evidently different from this species, and comes nearer to the *Pelasgus*, to which, however, the description does not very well apply, in many respects.

Family III. ÆGERIADÆ. H. *The Ægerians.*

Genus X. Trochilium. (Scop.) Stephens.

Sesia. F. (Entom. Syst.) Latr. Boisd. *Ægeria.* F. (Syst. Glossat.)

1. *T. marginatum.* H.

Black; wings transparent; first pair with a broad border, the tip, and a transverse band beyond the middle pale brown; hindwings with a broad black fringe; antennæ black; two longitudinal lines on the thorax, hind margins of the abdominal segments, orbits, palpi, and legs, except at base, yellow. Expands rather more than one inch and a quarter.

This insect was taken in New-Hampshire, and presented to me by the Rev. L. W. Leonard.

2. *T. tibiale.* H.

Brownish; wings transparent; first pair with a narrow border and an abbreviated band beyond the middle pale brown; hindwings with a narrow brownish fringe; antennæ black; orbits, two lines on the thorax, edges of the abdominal segments, and tibiæ yellow; hindmost tibiæ thickly covered with yellow hairs. Expands one inch and a half. The yellow bands on the abdomen are much narrower and less bright than in the *marginatum.*

Found in New-Hampshire on the *Populus candicans*, and presented to me by Mr. Leonard.

3. *T. denudatum.*

Chestnut-brown; fore-wings opaque, with a large triangular transparent spot adjacent to the outer hind-angle, a rust-red spot at base and another near the middle; hind-wings transparent, with the margin and fringe brown, and a rust-red costal spot; orbits, edges of the collar, incisures of the abdomen, tibiæ, and tarsi dull yellow; antennæ brownish above, rust-yellow at tip and beneath. Expands from one inch and a quarter to more than one inch and a half. The transparent spots at the tips of the fore-wings have the appearance of being caused by the removal of the colored scales.

The specimens, from which the descriptions of these three species are drawn up, had become somewhat oily, and it is possible that some of their characteristic markings may have become obliterated.

Genus XI. Ægeria. F. (Syst. Glossat.)

Sesia. F. (Entom. Syst.) Latr. Boisd. *Trochilium.* Scopoli.

1. *Æ. tricincta.* H. (Catalogue.)

Blue-black; fore-wings opaque; hind-wings transparent, with the border, fringe, and a short transverse line near the middle black; palpi at tip, collar, a spot on each shoulder, and three bands on the abdomen yellow; antennæ short, black; four posterior tibiæ banded with orange; tarsi yellow, tipped with black; tail flat, with two longitudinal yellow lines. Expands from one inch to one inch and two lines.

This species seems to come near to the European *Asiliformis;* but the male has only three yellow abdominal bands; while in the *Asiliformis* there are five bands in the male sex. The antennæ are shorter and thicker than in the following species, and are furnished beneath with a double row of short pectinations or teeth, which are thickly fringed with hairs. The sexes were captured together upon the common tansy.

2. *Æ. Cucurbitæ.* H. (New-England Farmer.)

Fore-wings opaque, lustrous olive-brown; hind-wings transparent, with the margin and fringe brown; antennæ greenish black; palpi pale yellow, with a little black tuft near the tip; thorax olive; abdomen deep orange, with a transverse basal black band, and a longitudinal row of five or six black spots; tibiæ and tarsi of the hind-legs thickly fringed on the inside with black, and on

the outside with long orange-colored hairs; spurs covered with white hairs. Expands from thirteen to fifteen lines. *Larva*, similar in form and color to those of other species of the genus, lives in the pith of squash and pumpkin vines, which it leaves at the root, and forms in the ground a cocoon composed of grains of earth cemented by a gummy matter. *Pupa*, by the aid of the abdominal denticulations, almost entirely excluded from the cocoon during the last transformation.

The sudden death of the squash-vines, during midsummer, is occasioned by the ravages of the larva of this insect. For further particulars relating to it, a communication, by the author, in the New-England Farmer, Vol. VIII, p. 33, for 1828, may be consulted. This species seems to be closely allied to, but sufficiently distinct from the *tibialis* of Drury, and the *Bombiliformis* of Cramer.

3. *Æ. caudata.* H. = *fulvicornis.* H.* (Catalogue.)

Brown; *male* with the fore-wings transparent from the base to the middle; hind-wings transparent, with a brownish border, fringe, and subcostal spot; antennæ, palpi, collar, and tarsi tawny yellow; hind-legs yellow, end of the tibiæ and first tarsal joint fringed with tawny yellow and black hairs; tail slender, cylindrical, nearly as long as the body, tawny yellow, with a little black tuft on each side at base. The *female* differs from the male in having the fore-wings entirely opaque; the hind-legs black, with a rusty spot in the middle of the tibiæ, and fringed with black; caudal tuft of the ordinary form and size. Expands from one inch to one inch and three lines. *Larva* inhabits the stems of our indigenous currant, *Ribes Floridum.*

The *Zygæna caudata*, of Fabricius, has a somewhat similar tail, but does not belong to the genus *Ægeria.*

4. *Æ. Syringæ.* H.

Brown; fore-wings with a transparent line at base; hind-wings transparent, with a brown border, fringe, and subcostal spot; antennæ, palpi, collar, first and second pairs of tarsi, and middle of the intermediate tibiæ rust-red; middle of the tibiæ and the tarsi of the hind-legs yellow. Expands one inch and two lines. *Larva* lives in the trunks of *Syringa vulgaris*, the common lilac.

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* Credited to Mr. Say, in the Catalogue of the Insects of Massachusetts, by mistake.

5. *Æ. exitiosa.* Say.

Steel-blue; *male* with the wings transparent, the margins and fringes, and a band beyond the middle of the first pair steel-blue; palpi, collar, edges of the shoulder-covers and of the abdominal segments, two bands on the tibiæ including the spurs, anterior tarsi, and lateral edges of the wedge-shaped tail pale yellow; *female* with the fore-wings opaque; the hind-wings transparent, with a broad opaque front-margin and the fringe purple-black; antennæ, palpi, legs, and abdomen steel-blue, the latter encircled in the middle by a broad saffron-colored band. Male expands from nine to thirteen lines; female from fifteen to seventeen lines. *Larva* inhabits the trunks and roots of the peach and cherry trees, beneath the bark.

The larva is the well-known peach-tree borer, which annually injures to a great extent or destroys numbers of these trees. For the means of preventing its ravages, see Say's Entomology, Vol. II, and my communication in the New England Farmer, Vol. V, p. 33. The insects above described, though very dissimilar, are really the sexes of one species. I have raised many of them from the larvæ, and have also repeatedly captured them, in connection, on the trunks of peach and cherry trees.

6. *Æ. fulvipes.* H. (Catalogue.)

Blue-black; wings transparent, margin and fringes, and a transverse band beyond the middle of the first pair blue-black; antennæ black, yellowish at the end; palpi beneath, a spot on the thorax under the origin of the wings, intermediate and hindmost tibiæ, all the tarsi, and the basal half of the underside of the abdomen orange-colored; hindmost tibiæ somewhat thickened by a covering of tawny hairs. Expands thirteen lines.

7. *Æ. Tipuliformis.* L.

Blue-black; wings transparent, with the margin and fringes blackish; the first pair with a transverse blue-black band beyond the middle, and a broad one at tip streaked with copper-color; antennæ black; palpi beneath, collar, upper edges of the shoulder-covers, a spot on each side of the breast, three narrow rings on the abdomen, ends of the tibiæ and the spurs pale golden yellow; tail fan-shaped, blue-black. The male has an additional transverse yellow line between the second and third abdominal bands. lines Expands from seven and a half to nine ~~inches.~~ *Larva* lives in the pith of the currant-bush.

This destructive insect is not a native, but has been introduced from Europe with the cultivated currant-bush.

8. *Æ. scitula.* H.

Purple-black; wings transparent, with the margins golden yellow; the first pair with a narrow purple-brown band beyond the middle and a broad one at the tip ornamented with golden yellow lines; fringes blackish; front and orbits covered with silvery white hairs; antennæ black; palpi, collar, upper edges of the shoulder-covers, a narrow band at the base of the abdomen, a dorsal spot behind it, a broad band around the middle, the lateral edges of the fan-shaped tail, anterior coxæ, sides of the breast, tibiæ and tarsi except at the joints, with the spurs golden yellow. Expands about eight lines.

This beautiful little species is easily distinguished by the prevalence of yellow on the under-side of the body and legs.

9. *Æ. Pyri.* H. (New-England Farmer.)

Purple-black; wings transparent, with the margins, a narrow band beyond the middle of the first pair, and a broad one at tip purple-black, the latter streaked with brassy yellow; antennæ blackish; palpi beneath, collar, edges of the shoulder-covers, a broad band across the middle of the abdomen, a narrow one before it, an indistinct transverse line at base, the posterior half of the abdomen beneath, the sides of the breast, anterior coxæ, legs except the joints of the tibiæ, and the lateral edges of the wedge-shaped tail golden yellow. Expands six lines and a half. *Larva* lives under the bark of the pear-tree.

For some further particulars respecting this species, see my communication in the New-England Farmer, Vol. IX. p. 2, 1830.

Mr. Edward Doubleday presented me with a new species of *Ægeria* which he captured in Florida, and Dr. J. W. Randall has still another which was taken in Massachusetts. To these gentlemen belongs the right of first naming and describing these species which they have discovered, and I do not feel myself authorized to anticipate them.

Genus XII. Thyris. Illiger.

T. maculata. H. (Catalogue.)

Brownish black, sprinkled with rust-yellow dots; hind-margins of the wings deeply scalloped, with the edges of the indentations white; each of the wings with a transparent white spot,

which in the fore-wings is nearly oval and slightly narrowed in the middle, in the hind-wings larger, kidney-shaped and almost divided in two; palpi beneath, a spot before the anterior coxæ, the tips of the tarsal joints above, and the hind-edges of the last three or four abdominal segments white. Expands from six to eight lines.

This species comes very near to the *fenestrata* of Europe, but is sufficiently distinct from it.

Mr. Doubleday has presented to me a much larger species of *Thyris*, which was captured by him in Florida, and was new to my collection. There is a figure of it in M. Boisduval's Hist. Nat. Ins. Lépidopt. Vol. I, pl. 14, where it is named *T. lugubris.* This name has not yet received the proper sanction of a description; but, taking into consideration the circumstances under which this nondescript came into my possession, I do not think proper to describe it myself at this time.

Tribe II. SPHINGES ADSCITÆ. L.

Family IV. AGARISTIADÆ. H. *The Agaristians.*

Hesperi-Sphinges. Latr. *Agaristides.* Boisd. *Zygænidæ.* Kirby.

Genus XIII. Alypia. (Hübner.) Kirby.

Zygæna and *Sesia.* F. *Agarista.* Latr.

A. octomaculata. F.

Black; with two sulphur-yellow spots on the fore-wings, and two white ones on the hind-wings; shoulder-covers and front sulphur-yellow; first and second pairs of tibiæ thickly covered with orange-colored hairs. Expands from eleven to fifteen lines. *Larva*, as represented by Abbot, (Ins. Georg. p. 8, pl. 44,) cylindrical, elongated; yellow, with transverse rows of black points, slightly hairy, and without a caudal horn. It lives on the grape-vine, and encloses itself in a cocoon in the earth.

In some individuals there is a white spot near the end of the abdomen, and the inner white spots of the hind-wings are enlarged and cover the whole base of the wings. Mr. Kirby (Fauna Bor. Amer. IV, p. 301, pl. 4, fig. 5,) has described another species of Alypia, a native of Nova Scotia and Canada, and names it A. MacCullochii.

Family V. ZYGÆNIADÆ. H. *The Zygænians.*

Zygænidæ. Stephens. *Zygénides.* Boisd.

Hitherto I have not met with any insects in the United States belonging to this family; but Dr. Hornbeck has sent to me, from St. Thomas, a species which not only seems to be undescribed, but must constitute a new genus, the characters of which are given in the Synopsis, and those of the species in the note below.*

Family VI. GLAUCOPIDIDÆ. H. *The Glaucopidians.*

Procrides and *Zygénides.* Boisd. *Zygæniadæ.* H. Cat. *Ctenuchidæ.* Kirby. *Callimorphæ.* Westwood.

Genus XV. PROCRIS. F.

Ino. Leach.

P. Americana. = *Aglaope Americana?* Boisd. = *dispar.* H. (Cat.)

Blue-black; with a saffron-colored collar, and a fan-shaped, somewhat bilobed, black caudal tuft. Expands from ten lines to one inch. *Larva*, according to Prof. Hentz, hairy, green, with black bands. It is gregarious, and devours the leaves of the grape-vine, and undergoes its transformations in an oblong-oval, tough, whitish cocoon, which is fastened to a leaf.

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* Genus XIV. MASTIGOCERA. H.

From μάστιξ, *a whip or thong*, and κέρα, *horns;* the antennæ being thickened in the middle and tapering at each end like a whip lash. In the West Indian insect to which I have applied this name, the antennæ agree, in the main, with those of *Ægocera*, as described by Latreille and other authors; but most of its other characters disagree, and it has an entirely different form from that of the type of the genus. These characters are so very striking, that I have ventured to propose this new genus, although the transformations of the species are unknown to me.

M. vespina. H.

Light rust-brown; wings immaculate; collar, first abdominal segments above, third below, and a triangular spot on each side, white; head, thickened part of the antennæ, edge of the thorax behind the collar, and a large triangular spot on each side of the second abdominal segment, black; breast black, spotted with white; first and second pairs of thighs, except at base, middle of the hind-pair, and extremity of the tibiæ, black. Expands from one and a half to one inch and three quarters. Inhabits the island of St. Thomas, W. I.

The *Zygæna Eunolphus* of Fabricius, and the *Pretus* of Cramer are probably congenerical and closely allied to this species.

This insect appears to be the same as the one figured in Guérin's Iconographie and in Griffith's Cuvier, under the name of *Aglaope Americana*, Boisduval; but it is not an *Aglaope*, for it has a distinct, spirally-rolled tongue.

Genus XVI. Glaucopis. F.

The insects which, at present, I refer to this genus, belong to *Zygæna* of the *Entomologia Systematica* of Fabricius; whose *Z. Glaucopis*, if it was not actually the type, furnished the generical name which this author gave, in his last work, the *Systema Glossatorum*, to this group of his former *Zygænæ*. Several of the insects, which Mr. Westwood, in his edition of Drury's Illustrations, refers to the genus *Callimorpha*, without doubt belong to the family *Glaucopididæ*. Mr. Kirby has placed one species, after *Lithosia*, in a family which he names *Ctenuchidæ*. These insects seem to me much more nearly allied to the *Sphinges adscitæ* than to the *Phalænæ* of Linnæus, with which also they agree in their diurnal flight, and in their transformations, so far as the latter are known. Although they do not appear to be strictly congenerical, I prefer to arrange them, for the present, under the genus *Glaucopis*, in groups or subgenera, which, when the larvæ and their transformations are better known, it may be proper to raise to the rank of independent genera.

Subgenus *Syntomeida*. H.

Antennæ bipectinated, tapering at each end. Tongue moderate, spirally rolled. Palpi short, not extending beyond the clypeus, slightly curved and hairy at base, covered with short close scales; terminal joint somewhat acuminated. Wings elongated, hind-pair small, with the discoidal cell closed behind by an acute-angled nervure, the anterior branch of which crosses the subcostal nervure and ends near the tip of the wing. Body cylindrical, rounded and not tufted behind, and with a rounded tubercle on each side of the first abdominal segment. Spurs of the posterior tibiæ four, small, and approximated.

1. *G.* (*S.*) *Ipomϫ.* = *Sesia Ipomϫ.* Œmler, in letters.

Fore-wings greenish black, with three yellowish white dots near the front margin and two others close together beyond the middle; hind-wings violet-black, with a transparent colorless spot at base; body tawny orange; antennæ and head black, the latter spotted with orange; a broad stripe on the shoulder-covers, a transverse spot on the thorax behind, and the incisures of the abdomen, black; legs violet-black; coxæ beneath, and a spot on the thighs, orange-colored. Expands one inch and three quarters.

I received this species from Dr. A. G. Œmler, of Savannah, Georgia, and have adopted the specific name that he gave to it, and from which it is to be presumed that the larva lives upon the *Ipomœa.* The *Melanthus* and *Nycteus* of Cramer resemble it somewhat, and are probably congenerical with it.

Subgenus *Cosmosoma.* Hübner.

Antennæ long, very much attenuated at the end, and with a double row of very short pectinations beneath. Tongue moderate, spirally rolled. Palpi long, curved upwards, and extending beyond the clypeus; the joints cylindrical, covered with small scales, a little hairy at base, and obtuse at tip. Wings elongated, hind pair rather small, and with the discoidal cell and nervures as in *Syntomeida.* Body cylindrical, rounded and not tufted behind, and with a small tubercle on each side of the first abdominal segment. Spurs of the hindmost tibiæ four and of moderate size.

2. *G.* (*C.*) *Omphale.* Hübner (according to Say). = *Ægeria Omphale.* Say.

Scarlet; wings transparent, veined and bordered with black, the first pair with a small black subcostal spot, and the black border very much widened at tip; head azure-blue; antennæ black, with the tips white; two terminal joints of the palpi, and a line on each shoulder-cover black; four azure-blue dots in a transverse row on the fore-part of the thorax; last four segments of the abdomen black, with four azure-blue spots on each side, and a dorsal black line extending from the middle of the second segment including in it seven azure-blue spots; belly and outside of the second pair of tibiæ black. Expands one inch and a half or more. Inhabits Florida.

For a specimen of this beautiful insect I am indebted to Mr. Doubleday. It cannot belong to the genus *Ægeria*, to which it was referred by Mr. Say, in his American Entomology, where it is figured. As Hübner's works are not accessible to me, I have drawn up the characters of the subgenus *Cosmosoma* from the specimen of the *Omphale* in my possession. *Zygæna Andromacha* of Fabricius and the *Caunus* of Cramer probably belong to the same subgenus.

Subgenus *Lycomorpha.* H.

Antennæ rather short, curved, toothed or with very short pectinations on each side, which give to the joints, when seen from beneath, a cordate or bilobed appearance. Tongue about half as long as the body, spirally rolled. Palpi short, hardly extending beyond the clypeus, nearly horizontal and but slightly curved at base, and covered with large and rather loose scales. Wings not elongated, rounded at tip; discoidal cell of the hind pair long, extending nearly to the hind-margin, and

closed by an oblique nervure. Body rather short, nearly cylindrical, not tufted behind. Spurs of the hind-legs three, two at the end and one beyond the middle of the tibiæ.

3. *G.* (*L.*) *Pholus.* Drury.

Blue-black, or deep indigo-blue, wings at base and shoulder-covers orange-colored. Expands fourteen or fifteen lines. *Larva*, according to Mr. Leonard, pale green, with yellowish spots running into the green (in a specimen preserved in spirit, pale green mottled with red;) head black, covered with a few short whitish hairs; body sparingly clothed with rather long hairs, which are white at the sides and black on the back, the hairs arising singly from minute tubercles, those on the third segment the longest and with the others before them directed forwards. It eats the lichens on stone heaps and walls in shady places, and undergoes its transformations in a thin silky cocoon.

This pretty species is often seen flying in considerable numbers in the fields, throughout the day, and at first sight would be mistaken for a species of *Lycus.*

Subgenus. *Ctenucha.* Kirby.

Antennæ pectinated on both sides in the males, thickened in the middle with extremely short pectinations in the females. Tongue moderate, spirally rolled. Palpi slender, rising beyond the clypeus, nearly cylindrical and obtuse, covered with small close scales, and somewhat hairy at base. Wings in some rather narrow, in others widened and rounded at the tip; discoidal cell of the hind pair closed by an angulated nervure. Body nearly cylindrical, enlarged a little behind in the females, with a few minute tufts at the sides of the segments, obtuse and slightly tufted at tip; first abdominal segment with a conspicuous tubercle on each side. Spurs of the hind-legs small, four in number, two terminal, and two beyond the middle of the tibiæ.

4. *G.* (*C.*) *semidiaphana.* H.

Slate-colored; wings rather narrow and subacute; first pair brownish slate, with the anterior edge clay-colored; hind-wings semitransparent in the middle; head and antennæ black; collar, front edge of the breast, and base of the palpi, orange-colored. Expands fifteen to sixteen lines. Inhabits the Middle and Southern States.

Dr. Charles Pickering, several years ago, gave me specimens of this insect, which he captured near Philadelphia; there are also specimens of it, in the cabinet of the Boston Society of Natural History, taken in North Carolina by Prof. Hentz; and I have recently received several individuals, in fine preservation, which were found by Mr. Doubleday in Florida. This species some-

what resembles, in form and color, the *Thetis* of Linnæus and Drury.

5. *G.* (*C.*) *Latreillana.* = *Ctenucha Latreillana.* Kirby. Fore-wings dusky drab, with a silky lustre, and the anterior edge clay-colored; hind-wings rusty black; fringes of all the wings white, interrupted with black in the middle; top of the head, orbits behind, base of the palpi, front of the breast, and a spot on the fore-part of each shoulder-cover orange-colored; thorax, abdomen, and coxæ, glaucous or greenish blue with a silky lustre; belly and legs light brown. Expands almost two inches. Inhabits New-Hampshire and Maine, and, according to Mr. Kirby, Canada and Nova-Scotia.

I am indebted to the Rev. L. W. Leonard for one specimen, taken by him in New-Hampshire, and to Dr. J. W. Randall for another from Maine. Although they are rather smaller than Mr. Kirby's *Latreillana*, and do not exactly agree with the description in the Fauna Bor. Amer. Vol. IV, p. 305, I think that they must be referred to his species. This insect has precisely the same antennæ and nearly the same form as the *Glaucopis* of Drury and Fabricius, stated by the latter author to be a native of Carolina, and is, without doubt, generically allied to it, and probably also to several other American species, such as the *Pylotis* and *collaris* of Drury. The following species, from the figures given of them, seem also to belong to the same generical group; viz. *Glauca*, *Celadon*, *Circe*, *Cœlestina*, *Asterea*, *Cephise*, *Alecton*, *Cassandra*, and *Porphyria* of Cramer.

Subgenus *Psychomorpha.* H. (Catalogue) = *Callimorpha.* Westwood.

Antennæ in the males pectinated on both sides, the pectinations rather short, setaceous in the female, according to Drury. Tongue moderate, spirally rolled. Palpi slender, nearly horizontal, extending a little beyond the clypeus, covered with loose hairs so as to conceal the joints. Wings short, somewhat triangular, with the outer margins rounded; discoidal cell of the hind pair short, closed by a sinuous nervure. Body slender, hairy at tip. Legs short, hairy; spurs of the hind tibiæ three, slender, nearly concealed by the hairs.

6. *G.* (*P.*) *Epimenis.* Drury. = *Psychomorpha maculata.* H. (Catalogue.)

Brownish black; fore-wings sprinkled in spots with light blue scales, which form a narrow band near the hinder margin, and marked with a large yellowish white patch beyond the middle; hind-wings with a broad dark orange-red band behind the middle. The white spot of the fore-wings is indented towards the

middle of the wing, and on the under side there is a small triangular spot near the base of the wing, and a short transverse one beyond it which unites behind with the angular projection of the large white patch. Expands rather more than one inch.

I captured this beautiful insect on the wing at midday, in Milton, Mass., and have since seen it flying among the shrubbery at Mount Auburn, Cambridge. There is also a broken specimen, among Mr. Say's insects, which was taken in Indiana. My specimen is a male, as is also the one in Mr. Say's cabinet, and they have the anal organs very large and hairy. Drury's specimen seems to have been a female, for he says the antennæ are setaceous. It is possible that this insect is not one of the *Sphinges adscitæ;* but I place it here on account of its diurnal habits, and a certain resemblance, more easily seen than described, which it bears to some of the *Glaucopididæ.* It does not agree generically with the types of Latreille's genus *Callimorpha.* When my Catalogue of the Insects of Massachusetts was published, I had not seen a colored copy of Drury's Illustrations, and failed to recognize this insect in the uncolored one which I used.

Cambridge, Mass., Feb. 1, 1839.

SCIENTIFIC TRACTS.

NUMBER VII.

ENTOMOLOGY.

Among the different sciences which of late years have been zealously studied in this portion of our country, none, perhaps, have received more attention than several branches of Natural History.

A taste for these pursuits is rapidly increasing, as the pleasure and instruction received from them are pointed out by those who have diligently and faithfully investigated them. But while peculiar circumstances have rendered some of these branches more popular than others, a few have been neglected almost altogether. Thus while the objects of some may have been eagerly sought after at much labor and pecuniary expense, and those of others have been carefully examined and accurately arranged, several have been permitted to remain unheeded and unsought for.

Mineralogy, indebted for much of its popularity as a science among us within a few years, to the brilliancy of a star in the East, has become not only a delightful pursuit for the student at our Universities, but an amusement for the man of leisure, and a fashionable recreation among the most wealthy.

The variety and beauty of our plants — the pleasing associations at all times recalled by reverting to the days of our childhood, when we so joyously plucked them — and the unusual facilities offered for their study, have rendered them the objects of general admiration. Few are there among us who have not some slight acquaintance with this fascinating branch; who cannot describe the parts which compose a flower, and distinguish many of our frequently observed species. Here we have great inducements to proceed, being furnished with many invaluable aids. Dictionaries and manuals, written in the

most simple and attractive manner, — freed from all the useless terms with which the older writers had embarrassed the subject, and pointing out its pleasures and advantages, have been afforded us by those who were well qualified for the arduous duty. An impetus was long since given; and the establishment of Professorships at our colleges, and the introduction of elementary works on this subject, not only into seminaries devoted to the education of our young ladies, but also into the schools of children, prove how desirable the possession of this branch of knowledge is considered. This taste, enthusiastic, as it may almost be called, is yearly increasing by means of the spirited efforts of our horticulturists, who, not content to cultivate the natives of our own soil alone, are continually introducing many varieties of rare and choice exotics.

Zoology has not been extensively studied with us. Comparatively few, very few, have devoted themselves to an examination of the animal world, although in each of its departments, individuals have distinguished themselves by their industry and talents; and invaluable papers relating to objects in most of these departments are treasured up in our scientific periodicals.

Our birds have been minutely and correctly described, and splendidly figured by Wilson, and Bonaparte, and Audubon; and we are soon to be gratified with a work on these animals from the pen of Nuttall, whose name is a sure pledge of the accuracy and perfection of the great undertaking.

Conchology, the study of shells, has been more attended to, than either of the other branches of this great division. The objects of this class are generally treasured up for their beauty; and on this account it is a favorite branch with our young ladies. Cabinets formed by them are often met with, showing a taste, and perseverance, and knowledge, of which they may well be proud

But while these branches are pursued with such unabating zeal, the same individual oftentimes takes but a cursory view of the most delightful branch of the works of nature — the Insect creation. To procure the humblest

moss, he will toil up the rugged mountain with eagerness, regardless alike of fatigue and exposure, and feel richly repaid by the possession of his undescribed treasure. For a beautiful shell, with cheerfulness will he part with his last dollar, and proudly add it to his finely polished and carefully arranged cabinet. But why, it may be asked, is the study of insects less cultivated than either of the other branches? Why have they each enthusiastic disciples wherever we may look, while those who devote themselves to this branch, are comparatively so few? Would the lover of nature, he who delights to retire from the scenes of a busy world, and amid the harmony about him, forget the bitterness of his daily cup, cherish a fond delight for the vegetable kingdom, or listen enraptured to the free and delicious notes of the joyous songsters, and not even capture the splendid object before him, or bestow upon it a passing moment, if from it he could reap either pleasure or advantage? I would endeavor to answer such questions, — to remove the objections which may exist to the study of entomology, and offer such motives as may appear why it should be cultivated with equal devotion as the other departments of Natural History.

OBJECTIONS.

Many an individual has in childhood imbibed an aversion for insects, from the circumstance of having met with them in his articles of food; or having observed them in situations, little to be desired either for their cleanliness or comfort; an aversion, which, like other early impressions, is extremely difficult to be removed; increasing, unless an effort be made to destroy it, in proportion to the frequency of the exposure. Who does not, if in his boyish days he has often noticed an insect hovering over a stagnant pool, or glutting itself with putrefying matter, particularly if he has seized that insect and found it not only overrun with parasites, but emitting a most offensive odour, even more unpleasant than that arising from its repast — who does not remember, that the mere presence of that insect, preserved perhaps by some zealous companion, did for a time recall the prejudices which were so early formed, and all the trifling

circumstances which existed to fix them? This disgust, occasioned by an individual, involuntarily leads many to avoid the whole class.

The *inconveniences* suffered from insects, and the injuries produced by them, cause many superficial observers to turn from these to other objects, more worthy their interest. The musquitto, and flea, and bug, leave impressions not easily to be effaced. The acute sufferings of a night are not forgotten for years. But when, in addition to these annoyances, our clothes, and furniture, and books, — the dearly collected specimens of the naturalist, and the cheaply purchased works of art are all ruined by various species of this class, no slight degree of philosophy is required, to revert to these animals without awakening unpleasant associations. And if beside these, we perceive the merciless destroyers blasting our forest and fruit trees, our most valuable vegetables and choicest plants, — depriving us of our grain when it is carefully gathered into store-houses, and thus adding to the distresses of the poor, when they are least able to bear them, it is not surprising that a feeling of uneasiness should often be awakened; nor that the mind which dwells upon the clouds only in the horizon, should forget that they are sometimes dispelled. The entomologist, even, cannot read the histories of some particular species, without agitation. The locust, for example, must ever excite a degree of terror in the minds of the most enthusiastic. Although Arabia appears to be the favorite resort of these dreaded intruders they have visited the other countries of Asia; and not only these, but Africa and Europe also have felt their unrelenting havoc. From the earliest times we have been taught to shudder at their devastations. And removed as far as we may be from the countries of this genus, we cannot carefully read of the ruin produced by them, without a sensation of horror. Not only do they destroy every part of plants, and trees, and grasses, the root, trunk, leaf, bud, fruit, with merciless voracity, but every green thing is swept off without distinction; thus depopulating nations, and carrying more dread with them than the most powerful armies. Nothing but desolation can be connected with a host of these, extending five hundred miles, and so dense that when on wing, like

an eclipse, they completely hide the sun. But this is not all. These immense multitudes, when they have destroyed everything about them, die; and their decomposing carcases often produce the plague. *One hundred thousand men* have been swept off in Africa in one season, and nearly a million of men and beasts in Italy, by this cause.

The *insignificance* of the animals belonging to this class, prevents many from engaging in the study. A senseless worm, say some, is unworthy the attention of man. Other objects should occupy his thoughts. Nobler pursuits should claim his precious time.

Others, alive to *sensibility*, at once shrink from a pursuit which to them appears cruel in the extreme, and thus suppress an inclination which might prompt them to become benefactors to their fellow-men.

MOTIVES TO THE STUDY OF THE SCIENCE.

Ought we not to remember with gratitude, such animals as are hourly removing from around us, the causes of uneasiness or the elements of disease? Should we avoid the medicinal plant, satisfied as we may be of its value, on account of its fetid, nauseating smell, one of its principal characteristics, which renders it discoverable by all? Should we not rather regard it the more for disclosing its nature to us, at our first meeting, while as yet we are strangers?

I have said that the inconveniences suffered from these animals deter many from examining them. What stronger argument, I would ask, can possibly be offered, why our attention should be directed to any subject than this — that by our ignorance of it, we are made to suffer; and that in proportion to our knowledge, are not only our inconveniences lessened, but our pleasures increased? This very circumstance, which is urged as an objection, prompts many a cultivator of the soil to become an entomologist; and thus he is enabled, not only to prevent the injuries which would have occurred to his own harvest, but also to render an essential service to thousands, who had previously suffered with him. If our persons are the objects of attack, additional motives exist. Not only will our ill-founded fears, as to the increase and ravages of any

particular species be removed, but we shall be able to lessen the degree of temporary inconvenience suffered from them, and also to ward off several loathsome diseases.

The *minuteness*, and apparently *imperfect formation* of these animals, undoubtedly deter many from becoming interested in their history. With no elevated mind could these circumstances be regarded as objections to their examination. They would rather present themselves, as strong reasons why this science should be pursued — as the defects here would be the mere absence of organs or powers possessed by others, destined for different purposes, and would most forcibly prove the existence of a plan in which can be traced consummate skill, creating at one moment the most complicated of living beings, — then leaving us to admire and wonder at the construction of objects, the simplicity of whose formation renders them more accessible to the comprehension of man. But if the absence of something which is essential for the performance of necessary operations be alone a defect, then no imperfection can be pointed at, as a characteristic of the animals whose history it is delightful to study. Furnished with faculties for the execution of all the purposes of their existence, no one can direct his attention to them unprejudiced, without finding himself involuntarily interested in their study: and when he discovers them possessed of all the senses he is blessed with, and observes, besides their perfect beauty and curious external formation, a something which he at times almost believes cannot be mere instinct — when he reflects upon operations, the magnitude of whose design can scarcely be realized, and whose completion can hardly be credited, he is compelled to exclaim like a distinguished Roman philosopher, when examining these same objects, 'the nature of things is never more complete than in the least things.'

From an erroneous idea that much *cruelty* must necessarily be exercised in the pursuit of this science, many are deterred from attending to it. If the individuals belonging to this class were as susceptible of suffering as those of some other classes, — and were it absolutely ne-

cessary that *many* individuals of the same family should be destroyed in order to become acquainted with their histories, then might this be offered as an objection. But although all the senses are possessed, they do not exist with the same power as in other classes. It is not an uncommon circumstance for an insect to leave a leg in the hands of the entomologist, and not only fly off apparently as joyous as ever, but in a moment to alight and partake of its accustomed food. Kirby remarks, 'I have seen the common cockchaffer walk about with apparent indifference after some bird had nearly emptied its body of its viscera. An humble-bee will eat honey with greediness, though deprived of its abdomen. And I myself lately saw an ant, which had been brought out of the nest by its comrades, walk when deprived of its head. The head of a wasp will attempt to bite after it is separated from the rest of the body; and the abdomen under similar circumstances, if the finger be moved to it, will attempt to sting.' M. Riboud speaks of a beetle which survived fourteen days with a pin passed through it, as thick as its thigh. Dalyell relates that a butterfly lived a month after being stuck through with a pin, and after he thought it had been destroyed by sulphur. And our own Say tells us, that he observed a butterfly feeding with eagerness after it had escaped from him, impaled with a pin. Leuwenhoek had a mite which lived eleven weeks, stuck on the point of a needle, under his microscope. Vaillant, the African traveller, endeavoring to preserve a locust, took out the intestines, and filled the abdomen with cotton, and then fixed it down by a pin through the thorax: yet after five months the animal still moved its feet and antennæ. But if these remarks do not prove this objection to be ill-founded, I will change the argument. If suffering should be borne, — if a confined insect should be made to endure agonizing struggles, — if by its captivity any useful purpose can be gained, the entomologist cannot be called cruel. Cruelty implies the 'unnecessary infliction of suffering,' to gratify depraved feelings; the disposition to inflict pain, when no possible benefit can be derived from such an act. But it is not shown by pursuing any department of natural history, when the feel-

ings which prompt us to study them are the most generous and elevated of our natures.

Having dwelt upon such objections as would most probably be offered to the cultivation of this science, by those who oppose it, and having endeavored to show their futility, a few inducements shall be offered to its study.

We are so prone to avoid whatever at first sight is displeasing, so willing to lend a ready ear to whatever lessens the value of any object, so liable to be more impressed by the remembrance of an injury than the possession of a blessing, that most of mankind pass by this noble, elevating study, as if it were useless; and forgetting the utility of many of this class of creation, see in it nothing which should employ the rational mind. These incorrect views are removed solely by observation and reflection. No one department of the works of nature exhibits more powerful motives for its successful cultivation than this, if the number, variety, beauty, or perfection of its subjects be considered. At all seasons, and in almost every situation, individuals may be observed belonging to this class. The lovers of other branches may make but comparatively few additions to the objects they already possess. But the entomologist, even if he should be confined to the close and less pure air of a city, and allowed to travel over paved streets only, and this too, while in the performance of his necessary duties, has frequent opportunities of noticing species with which previously he had been unacquainted. And to the naturalist, what can be more grateful, than to find, wherever he may go, some new object to admire, some fresh incentive to the pursuit of his favorite study. To the lover of nature, the argument just offered will appear weighty. But I am well aware many will require stronger reasons, than that facilities exist for the cultivation of a science, and that much gratification of feeling is to be derived from attending to it, ere they think it worthy their consideration.

For such, other reasons can be offered, strong enough to convince any one of its advantages. As the agriculturist, by a minute acquaintance with the habits of this order of beings, is enabled to prevent in a great degree the injuries he would otherwise inevitably be compelled

to suffer, so is he restrained from much useless labor, and no little voluntary suffering. He neither amuses us by burying in the earth, with the intention of destroying them, immense quantities of caterpillars which spend a part of their lives there; nor by cutting down valuable trees, to spare others, because the insects which inhabit both, appear to him as belonging to the same species. He is enabled also to discover that some of our most common insects are of much value to him, in checking the increase of others, which would be injurious to his crops. An acquaintance with this subject will also remove many erroneous ideas which had been formed respecting the characters of these individuals, and the purposes for which they were created. The ticking of the *death-watch* will no longer be listened to with silent shuddering; nor will the protuberance on the oak leaf be examined with fearful forebodings, but the fœtal larva will be allowed quietly to go on to perfection, whether it foretels war, pestilence, or famine; and the minutest and most neglected insect, when the purposes of its existence are well known, will prove how injurious oftentimes are preconceived opinions.

IMMEDIATE ADVANTAGES DERIVED FROM INSECTS.

Another reason should be dwelt upon. The direct benefits derived from the individuals belonging to this class, should claim for them a greater share of attention. Well do I know, that all other arguments which can be offered, are slight in comparison with this. We are ever ready to engage in a pursuit, when it affords a prospect of remuneration, which before hardly claimed a thought; and often become from this cause zealous enthusiasts, where previously we had studiously avoided engaging our feelings. And here, I would refer particularly to the immense profits which may be received from insects, as articles of commerce. None, save those who have particularly attended to this subject, can for a moment conceive the extent of this traffic. Not only are various species used in the arts, but in some countries as articles of food, many have an extensive circulation. A few examples only shall be offered at the present time. To entomology must we look for several of our most beautiful and valuable dyes. A

perfect scarlet is obtained from the same insect whose secretion, under the name of Lac, is applied to so many useful purposes; and with the crimson dye of the Cochineal insect, all are familiar. This insect, the Coccus Cacti, is a native of South America, and is particularly cultivated in Mexico. When the female, which is alone valuable, has arrived at its perfect state, it fixes itself to the surface of the leaf, and encloses itself in a white cottony matter which it secretes. When it has deposited all its eggs, it shrivels and dies; but as its colouring qualities are thus destroyed, those who raise them are careful to kill them before this time, which they do by brushing them off the plants, and applying the fumes of hot vinegar, or throwing them into boiling water; they are then dried and imported into Europe. The cultivation of the cochineal insect requires much attention, and the gathering of them also. But the time of those thus occupied is well employed, this insect furnishing the most valuable dye obtained from this class of animals. Humboldt tells us, that the quantity annually exported from South America, is there worth upwards of five hundred thousand pounds sterling; and it has been said that the Spanish government is yearly more enriched by this article, than by the produce of all its gold mines. The directors of the East India Company offered a reward of six thousand pounds to any one who should introduce it into India. In commerce, this article is almost always adulterated, different substances being mixed with it, and colored by it; and Dr Paris, in his Pharmacologia, remarks, that a very considerable number of women and children get a support in London, by forming in moulds made for that purpose, particles of dough, and coloring them with cochineal.

The Lac insect referred to above, another species of Coccus, lives upon a species of Rhamnus. It is nourished by the tree, and there deposits its eggs, which it defends by this secretion, which also serves as a habitation for the perfect insect, and answers for food to the larva. This lac is formed into cells, finished with much regularity and art. The flies are invited to deposit their eggs on the branches of the tree, by besmearing them with some of the fresh lac steeped in water, which attracts

them, and thus gives a larger crop. When purified — which is done by first removing the twigs, leaves, and all the foreign substances, then breaking it into small pieces, placing them in a canvas bag, which is applied to the fire until the liquid lac passes through its pores, when it is taken off the fire and pressed — it is used for making sealing-wax, beads, rings, and various ornaments.

The Bee also furnishes an article of much importance; honey, the juice of plants, changed in its properties while in the stomach of the bee, is no small source of revenue to many individuals. Although most of the honey consumed is obtained from the hive-bee, great quantities are in various countries collected from different species of wild bees. Thus, in South America, much is obtained from nests in the trunks of trees. The beautiful rock-honey is also the produce of wild bees, which form their nests to rocks. Large quantities of hives of a bee differing from our common bee, are carried to different situations on the Nile, as the food of the bees at different places, fails them. The French have learned a lesson from this, and been profited. As the flowers decrease at any particular spot, compelling the bees to go far from their hives, the proprietors of the hives place them on a barge well covered, and they pass down the rivers, collecting the honey on the banks. In Spain the number of bee-hives is very great: Mills relates that a single priest was known to possess five thousand hives.

Wax, a substance which is secreted from honey, and transpires through the pores of the skin of the bee, and the article of which the bee forms its comb, is to some countries a source of great revenue. Thus we are told, that upwards of eightythree thousand pounds' value are annually sent from Cuba to New Spain; and that the whole quantity exported from the same island, has been worth upwards of one hundred and thirty thousand pounds in a year. By those who are never satisfied of the expediency of any object, who would prefer to receive everything of others, rather than make the slightest effort themselves, objections have been advanced as to the probability of our succeeding in rearing bees in New England. Our mild weather continues so short a time, say they, that the

bees have time enough only to provide a sufficiency for their own wants during the remainder of the year. We ought not to be surprised at the misrepresentations of foreigners respecting our climate, while we have so many traducers at home; nor feel irritated at the insinuations which would imply the degeneracy of all created things in a traveller, while those who should repel are so ready to give such errors circulation. That much may be done has already been proved in many of our States. And if at any particular spots it is desirable to establish hives, previous to the growth of such seed as may be sown, they might be moved as in Egypt and France, to points where food may be found in great abundance, and afterwards restored to the appointed place. But even if this should be impracticable, and if the quantity of honey produced by the bees were but little besides what would be necessary for them, if they should be allowed to feed continually and to the extent of their appetites, much might be gained by placing the hives, after all the honey was collected, in situations where the temperature should be so low as to render the bees inactive, and consequently requiring but little to nourish them, until the returning spring.

* The product of another insect, the caterpillar of a *moth*, whether it be looked upon as an article of commerce, or an object of domestic employment, is well worthy the attention of our country. The raising of silk-worms engaged the attention of an emperor of China, so long ago as twentyseven hundred years before the Christian era; and an empress first attended to the manufacture of silk. This occupation for a long time was confined to ladies of the most elevated standing; but gradually became an employment for females generally. After the quantity of silk manufactured was sufficient to clothe all classes in China, it was used as an article of exportation, and was carried from the northern parts of the Chinese dominions to every part of Asia. In 555, two monks brought from China in their hollow staves,

* The following remarks upon the silk worm have been previously inserted in a number of the Ladies' Magazine.

silk-worms' eggs to Constantinople; and thus Europe first became possessed of the power of raising silk. In Greece, as in China, females of the first families commenced the care of silk-worms. Next to Greece, Italy attended to the rearing of these insects. About the year 1600, Henry IV. introduced the raising of silk-worms into France, which now derives from their labors 23,560,000 francs annually. Although in 1180, silk was imported into England from China, which was earlier than it had been received in France, still nothing of importance was done towards the introduction of the caterpillar into England, until within the last eleven years,—two hundred years after France had set the example. Although two preceding attempts had failed to render the cultivation of silk important in Germany, during the past twelve years great efforts have been made there, originating with the Agricultural Society of Bavaria. Prussia and Sweden also, have not been idle; and in the former of these, it has been proved, that 'silk equal to that of Italy may be produced, affording greater profit than any other branch of rural industry;' while that raised in the latter country would show 'that the silk raised near the polar circle, is equal in strength and firmness to any species cultivated in more temperate climates.'

The cultivation of the silk-worm in this country, is becoming an object of so much importance, that during the year 1828, the Senate of the United States, ordered 2000 copies of a letter from the Secretary of the Treasury, transmitting all the information which could be collected respecting the cultivation of silk in the Union, to be printed for the use of its members. In Virginia, Georgia and South Carolina, the silk-worm has been reared for many years. In 1760, silk was first raised in Connecticut. Since then in New Hampshire, Vermont, Massachusetts and very lately in Maine, this subject has attracted the attention of economists. Connecticut has been eminently successful in her efforts:—in 1825, in the town of Mansfield alone, in that State, the silk manufactured was three hundred pounds—valued at *fifteen thousand dollars*:—in 1826, the County of Windham manufactured silk to the amount of fiftyfour thousand

dollars. It is estimated that five thousand dollars' worth of silk is annually sold in one County, (Orange County) in New York; and the whole sale of this article in that State, is calculated at fifteen thousand dollars. When it is considered that the greater part of the labor may be accomplished by females and children, and that it is not only a healthful exercise, but an agreeable amusement, it will be thought not a little surprising, that we are so willing and ready to import silk from abroad.

A GENERAL VIEW OF THE INJURIES AND BENEFITS PRODUCED BY EACH ORDER OF INSECTS.

But perhaps *many* might be persuaded to engage in the study of entomology, if the benefits derived from, and the injuries produced by each order of insects, were exhibited in a general manner, that they might be readily compared.

The first order is called Coleoptera, from the Greek words *koleos*, a sheath — and *pteron*, a wing — referring to the strong elytra or external wings, which protect the true wings. Among the genera of this order which are most common, are the beetle, stag-beetle, carrion-bug, weevil, lady-bird, blistering-fly, water-beetle, &c, &c. From the ravages of the first order of insects, man suffers extremely: — although our *persons* are incommoded as little perhaps by the animals belonging to this order, as either of the other orders, still the objects by which we are surrounded, those necessary to our *subsistence*, as well as articles of luxury and ease, are all subject to their depredations.

But if the many are not useful, the few are of infinite value. Decomposing substances, while they are removed from our view, are carried by these animals into the earth, and thereby tend to enrich vegetation. Noxious genera are held in detestation by others, which offer us no molestation, while some species afford subsistence to others. Thus the Aphides, the small flies, or (as they are generally called) lice, so common upon many of our plants, are in some seasons devoured in immense quantities by our beautiful lady-birds; and the females of the cockchaffer, one of the most injurious of the tribe to the

agriculturist, are destroyed at the moment they are most to be dreaded, by the genus of Ground-beetles. Nor do these afford sustenance to animals of the same scientific class alone. Our native birds, those which follow on wherever cultivation is, — whose delightful notes meet the ear at the rising of the sun, — whose melody cheers the husbandman fatigued at noonday, — and by whose evening concerts the pure heart is elevated and enraptured, — which teach us a glorious lesson of confidence, by rearing and educating their young at our very doors— these also are provided for by the existence of noxious insects : — and little does he study his own interest, whose selfishness causes their destruction. Other animals also feed upon insects. I am not compelled to go back to the Romans, to speak of their larvæ fattened to glut the appetites of epicures; nor to point to the African greedily devouring his roasted caterpillar, while the larvæ of one of the largest species of beetle, is at the present day an article of luxury with many in South America, and is served up at the tables of some of the most wealthy inhabitants of the West India islands. But from no insect belonging to this order, I might almost have said this class, do we derive so much benefit as from the genus Melœ, in which is found the blistering-fly. The blistering, or as it is called in commerce, the Spanish-fly, is found in large quantities in the South of Europe ; and is particularly abundant in Spain. They are collected from the leaves of different trees in summer, and are afterwards destroyed by the fumes of vinegar, and dried in the sun ; when applied externally to the human body, they act as a powerful vesicatory ; when given internally, as a stimulant of great efficacy. In many derangements of the system, they are, in the hands of the judicious practitioner, the means of preserving many of our race. When exhibited by the ignorant empiric, they are not unfrequently productive of the most severe sufferings and lamentable deaths. Our common *potato-fly* is one of this genus of insects, and while it possesses all the virtues of the Spanish-fly, it does not produce the bad symptoms, which often attend the employment of that remedy: and Professor Barton of Philadelphia, after

employing both for a long time in his practice, gave the preference to our native fly. It however cannot be collected here in sufficient quantities to supply the demand, and consequently is not so much used as the foreign insect. The active virtues of the Blistering-fly, depend upon the existence of a *principle*, which has obtained the name of *Cantharidin*.

The second order, is named *Hemiptera*, from *emisu*, the half, and *pteron*, a wing. The outer wings of this order, are semicoriaceous: they are not so strong as those of the first order, but more so than the remaining orders. This includes the cockroach, locust, lantern-fly, water-scorpion, bug-plant, louse, &c, &c. The 1st genus, as arranged by Linnæus, is the cockroach: this is an extremely troublesome animal, not only destroying our articles of food, but in many cases, our garments and books. By the ravages of the Aphis, or plant-louse, whole crops are often destroyed; our esculents and valuable plants; our fruit trees, as well as those of our woods, are all injured by this insect: by suction, it abstracts from the tender shoot its nutriment, and blasts the leaf by its peculiar secretion. This secretion is sometimes enormous; and not only by its quantity completely encases the plant, but by its saccharine nature, affords a resting place for noxious insects. The cocci also, which look like protuberances upon the stalks of plants, do considerable injury by drawing off the sap, and thus destroying life. To refer to any more genera of this order, would be needless. It is time to turn to those of this order which are of value to us. In speaking of the advantages derived from many insects of the preceding order, I referred to some which kept other species in check, by subsisting upon them. In this order we find the Mantis tribe; those whose peculiar appearance has given the idea of sanctity, one of the most ferocious tribes of insects, even carrying there animosities so far as to destroy each other. But to the coccus are we to look, as the most valuable genus of this order. By a species of this genus, is produced the Pe-la, or white wax of China. The Chinese cherish these insects by stocking some species of trees with them. This secretion begins

to appear about the commencement of summer, and is collected in the autumn. This wax is used by the nobility, and also by public speakers, to excite them. To the Lac, and also to the Cochineal Coccus, I have referred above. Besides the dying property of the Cochineal Coccus, while many unhesitatingly deny it any medicinal virtues, it is still employed by numerous physicians of experience and eminence, as a stimulant medicine.

Like the larvæ of the preceding order, some of the individuals belonging to this, are used as articles of food. That genus which has often produced such extensive suffering, the locust, has in many countries had its devourers. At Mecca, in times of famine, they have been ground up and mixed with flour for cakes: in Greece, and the Barbary powers, they have been an article of merchandize; and the Hottentots, although their vegetation may be ruined, joyously fatten themselves upon cooked locusts.

The third order is composed of such insects as have their wings covered with scales. This is called *Lepidoptera*, from *lepis*, a scale. Three genera only are included in this order. The butterfly, hawkmoth and moth. The individuals of this order are the most beautiful of the class, and often claim the admiration of those who would absurdly cherish for others an inexplicable disgust. Few as are the genera belonging to this order, their ravages are far from being slight;—their advantages are far from unimportant—although the caterpillars of the 1st genus, Papilio, the butterfly, are sometimes slightly pernicious, to the other genera, the moth and hawkmoth, we are to look principally for the causes of our injuries. A species of moth does incredible mischief in some seasons to grass. We are told that about half a century since, the fields of Sweden were rendered quite dry by these, as if a fire had passed over them. A small species of moth destroys our grain; our vegetables also suffer from their inroads; while others destroy the bark, and leaves, and blossoms of our fruit trees. Many forests also, in our country, have thus been seriously injured. The foliage being removed when the heat was very great, the unsheltered trunks have

yielded up their lives. The vine, too, is often entirely destroyed by a caterpillar of this genus, on the borders of the Black Sea: as soon as the buds open, they eat them off, especially the fruit buds, and devour the germ of the grape: two or three of these caterpillars will so injure a vine, by passing from one germ to another, that it will bear no fruit the next year. But their depredations are not confined to the vegetable kingdom. The larvæ of several species of moths do much injury to the hive bee; inclosing themselves in tubes of wax, they dwell there, unmindful of the bees. Our farmers have been almost discouraged some seasons, by the depredations of a moth, which utterly ruins their hives, and which has obtained the name generally, of the bee-moth. As however, it is ascertained that the perfect insect deposits its eggs only in clear dry spots, it is thought the evil may, in a great measure, be removed, by placing the hives upon the ground, or strewing earth to the depth of several inches upon their floors. Experiments lead us to hope much will be gained by this method of hiving. Nor are insects the only animals affected—man himself is not wholly exempt from their attacks. We are told by Azara, that in South America, there is a large brown moth, which deposits its eggs in a kind of saliva, upon the flesh of persons sleeping naked; introducing themselves under the skin without being perceived, they occasion swelling, accompanied by much pain and inflammation. Although the caterpillars of this order are, among the Chinese, and the inhabitants of New Holland, an article of *food*, and are considered by the Moors one of their greatest delicacies, our chief advantage is derived from individuals of the third genus, Phalena—the moth—and from that species particularly, which subsists upon the white mulberry tree, and supplies us with silk.

Insects having four membranaceous, naked wings, reticulated with veins, or in which the membranes look like net work, make up the fourth order, which is called *Neuroptera*, from *neuron*—a nerve. The dragon-fly, may-fly, and spring-fly, are among the genera of this order. Although the benefits received from this order are of less magnitude than those derived from several others, the

injuries suffered from its subjects are unimportant, and I might say, unknown. The voracious and tyrannical *dragon-fly*, may perhaps destroy in its fury many species of insects, which are of value to the husbandman ; but as its instinct prompts it to feed upon many noxious species, it ought perhaps to be regarded as a blessing, rather than a curse. The next genus, Ephemera, the spring-fly, although its existence is continued but a day, affords a valuable substitute to many farmers in Europe for manure. Scopoli, the historian of the insects of Carniola, remarks that the peasants in his neighborhood are dissatisfied, unless they can individually, collect at the times of their appearance, at least twenty cart loads, to strew over their grounds. The Hemerobius, or golden-eye, in its larvæ state, is of great value also, in the destruction of the Aphides, or *plant-lice*.

The fifth order has four membranaceous, naked wings, and is called *Hymenoptera*, from *umen*, a membrane. This order has been ranked at the head of the class by some naturalists, on account of their admirable economy. The gall-fly, saw-fly, ichneumon-fly, wasp, bee and ant, are arranged by Linnæus, in this order of insects. Some genera are extremely injurious, while others are of immense value.

The Cynips, or gall-fly, when its larvæ are deposited in unusual numbers upon a leaf, must detract largely from its nourishment: consequently, whole trees may, in some seasons, suffer from their presence. The second genus, Tenthredo, commonly called saw-fly, is the most dreaded insect of this order—its vulgar name is derived from the instrument by which it makes an incision in a leaf; this instrument, is a *double saw*, which in using, the insect first throws out one, then the other alternately, until a sufficient incision is made; when they are both retracted, and the egg is deposited from between them. Although the larvæ of this genus generally feed on the rose, and the willow tree, our grain, vegetables and fruit trees, have been at times, seriously injured. One species of these larvæ, which has received the name of slug-worm, and which has been admirably described, its changes and its injuries, by the late Professor Peck, in a volume of the

papers of the Massachusetts Agricultural Society, caused serious alarm in this country, about thirty years since. At that time, some of our most valuable trees were completely stripped of their leaves, and the crops of the succeeding years blasted by their ravages. I will not speak of the stings of the bee, nor the wasp, nor the Ichneumon-fly, for although I, with others, may have suffered from their venom, the suffering was deserved, and I am inclined to believe, that in almost every case, in which injuries are produced by these insects, they act on the defensive.

This order of insects is extremely important. If the injuries produced by them have been minutely detailed, obligations for benefits received shall be as readily acknowledged. And here, as strongly, perhaps, as in any order of nature, do we observe the necessity of understanding perfectly the character of an individual before we decide upon merits — of reflecting upon the ends of actions, before we think of them as worse than useless. Thus the protuberances upon our leaves, produced by the gall-fly, while they disfigure them, and in some instances greatly injure the tree, thus causing vexation to the possessors, not only are eaten as delicacies by the inhabitants of the Levant, and form a considerable article of commerce at Constantinople, where, preserved, they are exposed for sale, but they also furnish us with a valuable dyeing material; and what is of still greater importance, we are indebted to them for the means of forming ink.

The ant, too—little do we think, when incommoded by this genus, that any of its species are important to man: but we find, upon reflection, that the anatomist entrusts his nicest dissections to the inmates of an ant-hill, with perfect confidence in their skill. The cockroach in Ceylon, is destroyed by a species of ant — and in the eighth volume of the Quarterly Journal of Science, Literature and the Arts, is a very interesting paper by a Capt. Bagnald, who says, while in the West-Indies, he had repeated opportunities of watching the movements of these insects; he saw them often destroy spiders and cockroaches, and upon one occasion, he observed them

encounter a centipede, which, however, they did not put to death, until they had completely encrusted him; and though in the conflict, thousands of them were destroyed, they finally killed him. Nor are these all the advantages derived from them: a low priced brandy is made in Sweden, of rye and ants — these insects supplying a resin, an oil, and an acid. And in that country, they are not unfrequently eaten uncooked, for their acid taste; the devourers first plucking off their heads and wings. The ichneumon-fly is of essential service, in depositing its eggs, in the eggs or as yet imbecile larvæ — or by checking the progress of the powerful and voracious caterpillar. The sphex, or ichneumon-wasp, is a destroyer of the cockroach; wasps destroy for us immense quantities of flies — and in the interior of New England, their paper nests are used in affections of the lungs.— What their virtues are, the writer knows not: the substance by which they unite the particles of their nests together may perhaps be of a stimulating quality, and thus be enabled to relieve the existing stricture. But the Bee, which has been already dwelt upon, is the most valuable insect of this order.

If in speaking of the order Neuroptera, it was remarked that the injuries they produced were of but small consideration, I must here notice an order, in which but little obvious advantage is perceived, to compensate for its powers of annoyance.

The sixth order of Insects is called *Diptera*—from *dis*, twice, or double; they having but two wings. In this order, we find the various kinds of flies and the musquitto; here we observe not only genera which attack our provisions and ruin them, which harass, and render furious our cattle, and horses, and flocks, but also those which avoid less palatable food, to regale themselves with the blood of man. The first genus, Œstrus, the gad-fly, is the most troublesome, which affects our domestic animals. The gad-fly of the ox, deposits its eggs in the body of that animal, and thus the larvæ are provided for, during the whole winter. You may imagine how troublesome such an insect must be to the animal, particularly if it should suffer from indisposition after the deposition

of the egg. Another species, by irritating the lips of the horse in its endeavors to deposit its eggs there, renders the animal almost ungovernable: while the larvæ of a third species, hatching in the stomach of this animal from eggs introduced by its tongue, produce a disease, oftentimes severe, and which receives its name from the larvæ which produce it. Our inoffensive flocks too, are compelled to suffer from a species of gad-fly, which, depositing its eggs in the nostrils of the animal, feeds in the larvæ state upon the delicate membrane there, causing extreme distress, and not unfrequently, by insinuating itself into the brain, produces death. But these are not the only sufferers: not only does a species of gad-fly deposit its eggs in the abdomen of man, causing great irritation and suffering, in the torrid zone, but in some cases, even destroys life. The larvæ of the second genus, Tipula, the crane-fly, in some seasons, do much injury to grass, wheat and corn, by burrowing in their roots. With the inconveniences of the third genus, Musca, the fly, all must be conversant: by this genus, our articles of luxury are tarnished, our provisions destroyed, our persons molested, — while some species, not satisfied with one substance, attack all provisions which may be gathered for use by the husbandman: others are abroad, depositing the seeds of ruin in our grain, disappointing the hard working agriculturist. One species, a few years since in this country, from its ravages in our wheat fields, caused no common alarm. Nor is it to be wondered at, that the Hessian-fly should now be thought of with terror, when it is remembered, that it not only attacked this grain as soon as it began to grow, and destroyed every part of it, but also by depositing its eggs in the stem, so weakened it, as to prevent the ear from ripening. Another genus, Tabanus, the whame-fly, is at times very troublesome. The horse is a principal sufferer from their attacks—although in Africa, the inhabitants of whole counties are compelled to emigrate yearly to the locations of sand, to prevent their cattle from being destroyed by the attacks of this insect. The Culex, or gnat, remains to be noticed—the greatest plague of this order. Annoying as the musquitto is to us, when travelling in the vicin-

ity of marshes, or when our rooms are lighted during the evenings of summer — we have but little reason for complaint, when we observe their ravages in other countries. It is said that in South America, soldiers are sometimes forced to sleep with their heads thrust into holes in the earth, made with their bayonets, and to wrap round their necks their hammocks; that a king of Persia, his army having been completely exhausted by these insects, has been compelled to raise the siege of cities: that the Laplander is barely able to exist, with every means of defence he can employ; and that the Russian soldier, although sleeping in a sack, is not always able to live under such excessive irritation. And for all the sufferings experienced from this order, decomposing matter is removed by the infinite tribe of flies, which on every side surrounds us. The larvæ of one species, the inmate of putrid cheese, is a delicious repast for the refined epicure; and it is conjectured that the larvæ of the gad fly, which exhaust the poor horse, are in some cases, a gentle and beneficial stimulant.

The seventh and last order, is called *Aptera*—from *a*, primitive, and *pteron*, wing, and includes all such insects as want wings, in either sex. This order includes the Lepismæ, commonly called moths; Termites, or white-ants; Pedicalus, the louse; Palex, the flea; &c, &c. The termites or white-ants, are extremely numerous in warm countries, and very destructive, although wood is their common food; clothes, furniture, books, and almost a manufactured articles, are ruined by them. They curiously avoid injuring the exterior of substances, while they are destroying all within; houses are ruined by them; and when vessels are so unfortunate as to receive any on board of them, much injury is suffered. The genus Pediculus, louse, is very extensive. There is scarcely an animal or vegetable, that does not suffer from its own peculiar louse. Our domestic animals, as well as birds, fishes, plants, all have their lice—to man, it is extremely troublesome: but as it has been ascertained that the inconvenience is merely *external irritation*, we ought perhaps to consider it in the light of a proper reward for those who cherish them; as rarely, any one is annoyed,

unless really deserving of their attacks. The Pulex, or flea, and Acarus, or mite, are also included in this order, and are extremely troublesome.

Although other slight benefits have been derived from several genera, the insects of this order appear to be most extensively employed as articles of *food*.

It would be almost useless to mention any of the distinct and individual cases of this singular propensity; although they might be pointed at, among the most polished nations of Europe; because they would be considered perversions of taste, when the inhabitants of extensive tracts of country offer themselves as examples. The people of New Caledonia eat immense quantities of spiders; and all who have ever read of the Hottentots and Esquimaux Indians, must have been disgusted with their meals of lice.

In the compilation of the above Tract, the system of Linnæus the Swede, has been followed, on account of its conciseness, principally. The entomologist will at once perceive, that it was prepared for the *general reader*, and not for him who would be satisfied only with the more elaborate classifications of the great French naturalists.

"ON THE COLOURING MATTER OF SOME APHIDES,"

By H. C. Sorby, F.R.S., &c.

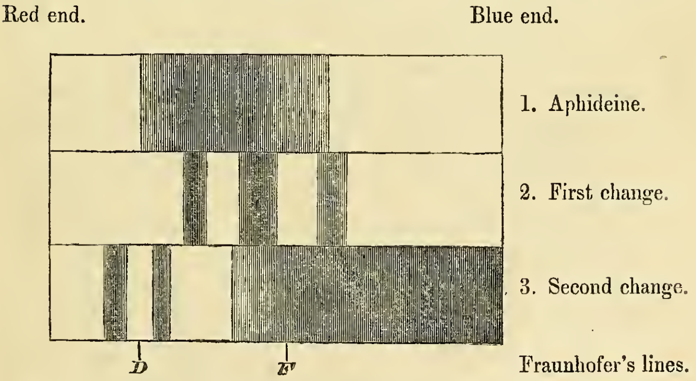
On the Colouring Matter *of some* Aphides.

By H. C. Sorby, F.R.S., &c.

Those who have orchards are no doubt often only too familiar with the red Aphides found in downy patches on the bark of the apple tree. These are coloured by a substance possessing somewhat remarkable properties, connecting it on the one hand with cochineal, and on the other with the hæmoglobin of the blood of vertebrate animals. It rapidly changes into a series of new products, which have remarkable optical characters, and are in some respects analogous to the colouring matters of oils and fats.

In order to obtain this red colouring matter in a state suitable for examination, the insects, fresh taken from the tree, should be crushed up in a small quantity of boiling water, and the solution filtered. It is then of a fine crimson colour, giving a spectrum with a broad general absorption, extending from the yellow over the whole of the green to the centre of the blue, without any well-marked narrow band, as shown in No. 1 of the accompanying fig. 1.

Fig. 1.—*Spectra of the light transmitted by aqueous solutions.*



The addition of a small quantity of citric acid immediately alters the colour to yellow, and then the spectrum merely shows an absorption of the blue end, extending to about the centre of the green, without any definite absorption-bands. A little ammonia restores the colour to its original state, and therefore the crimson colour is characteristic of a neutral or

slightly alkaline solution. When a small quantity of the double sulphate of protoxide of iron and ammonia is added to the solution in its natural state (as in all similar cases, using along with it some of the double tartrate of potash and soda, to prevent the precipitation of oxide of iron), it is changed at once to a pale flesh-colour; and, if a little ammonia had been previously added, the solution becomes quite colourless. On exposure to the air, it changes back again to the original tint, from the surface downwards. No such alteration is produced by adding the ferrous salt to an acid solution. This red substance, therefore, like hæmoglobin and hæmatin, exists in an oxidised and in a deoxidised condition, and, like them, can be deoxidised by the above-named process only when the solution is somewhat alkaline. It thus seems reasonable to suppose that it may perform the same functions in the economy of those insects which contain it that hæmoglobin does in the case of the vertebrata. For convenience, it may be well to call this red colouring matter of Aphides *Aphideine.* It is entirely different from any substance on which they feed, and is the same in several species living on entirely different plants.

One of the remarkable peculiarities of hæmoglobin is that it can be changed into a number of substances, each giving a well-marked spectrum, and in this respect Aphideine is little, if at all, less remarkable. On very gradually adding a small quantity of hypochlorite of soda to a recently prepared solution, the original spectrum No. 1 is changed to that shown in No. 3; but the compound then formed changes quickly into another, the spectrum of which shows two similar narrow absorption-bands, somewhat nearer the red end, not removed by the addition of ammonia or citric acid, disappearing at once when the ferrous salt is added to an alkaline solution, and partially restored by reoxidisation, if not kept long in a deoxidised state. The same results may be obtained by using the Aphideine extracted cold by crushing the insects in a small quantity of water, but this solution, which is often turbid, changes so rapidly on exposure to the air, that it is difficult to examine it before it has been considerably altered. On crushing the living insects in a watch-glass with a little water, the solution is at first pink, but rapidly becomes orange. On pouring this off into another watch-glass, leaving it for a short time, and then pouring the comparatively clear solution into an experiment cell, it will be found that the original Aphideine has been completely altered. On adding a little ammonia, instead of the spectrum showing a broad, continuous band like No. 1, three well-marked narrow bands

are seen, as shown by No. 2. For the actual position of these and those in other spectra, I refer to the table given at the end of this paper.

The relative intensity of these three bands varies considerably, and this led me to conclude that two different substances were present, as was subsequently proved in the manner described in the sequel. A weak acid entirely removes the narrower band nearest the red end, raises the others somewhat, and develops a new band still nearer the extreme blue, which can only be seen with excellent sunlight. On adding the ferrous salt to the alkaline solution, the absorption-bands gradually vanish, and, if kept deoxidised for some time, a new compound is formed with an absorption-band between the orange and yellow, and another in the green, disappearing when reoxidised. On the contrary, if the solution which gives the spectrum No. 2 be kept for a while exposed to the air, it is gradually changed into another compound, giving the two absorption-bands shown in No. 3. On keeping still longer these disappear, and the spectrum shows only a general absorption extending over the blue and green without any narrow bands. I am therefore inclined to believe that the compounds which give spectrum No. 2 are gradually altered into two other substances, which when mixed give spectrum No. 3, the narrow bands being due to one and the greater part of the broad absorption of the blue end to the other. These two narrow bands are at once removed by citric acid. The addition of the ferrous salt to an alkaline solution also removes the bands, and they are restored if reoxidised in a short time. When the solution is kept for a day or two deoxidised, and then rapidly reoxidised, no bands make their appearance; but if, after having been thus kept deoxidised, the cell be exposed uncovered to the air, so as to reoxidise slowly, another compound is formed, which gives a spectrum with an absorption-band nearer the red end than that shown in No. 3, made much more faint by citric acid, removed at once by deoxidising the alkaline solution, and reappearing when reoxidised. Since some of these solutions are often turbid, it is requisite to use strong concentrated sunlight to penetrate through them.

It will thus be seen that by exposing the solution to the air Aphideine passes successively into four different coloured products, and by deoxidisation and by subsequent exposure two others are formed. These complicated changes do not thus rapidly occur in the comparatively pure solution obtained by boiling the insects in water. It seems requisite that it should contain some of the (perhaps albuminous) sub-

stances present when the insects are crushed up in cold water, which by their rapid decomposition seem to induce the above-named changes in the Aphideine itself.

In my paper on some compounds derived from the colouring matter of blood,[1] I briefly described some of the products of the oxidisation of hæmoglobin. Of these there are at least four, three of which are characterised by the presence of absorption-bands at the red end of their spectra when the solutions are deoxidised. The products of the change of Aphideine are in some respects analogous to these, only that except in one the bands are characteristic of the oxidised state. The physical and optical properties of Aphideine and its products differ completely from those of the colouring matter of the cochineal insects of commerce. Whether this is a normal constituent of the living insects or a product can only be decided by examining them when alive, which hitherto I have not been able to do. I have met with Aphideine only in several dark-coloured species of Aphides, but at the same time I must confess that my acquaintance with the colouring matters of insects is very limited.

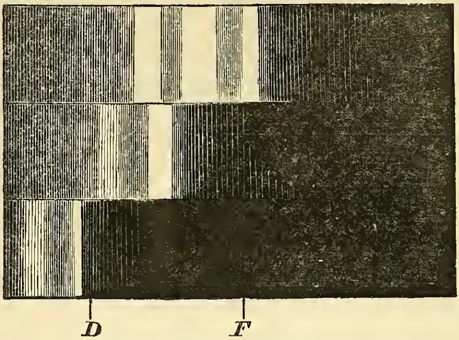
When carefully selected living Aphides of the apple tree are quickly crushed up in ether, and the clear solution agitated with about an equal quantity of water, it sinks to the bottom coloured pink-red by the Aphideine, whilst the supernatant ether is of pale yellow colour. On evaporating this to dryness, and dissolving in bisulphide of carbon, the yellow solution gives a spectrum without any decided absorption-bands, and seems to be coloured by a substance like that occurring in the fat or wax of other insects. If, however, similar living Aphides are crushed up in a test tube, kept in that state for a few minutes, and then treated with ether, on agitating with water it subsides almost colourless, whilst the ether is coloured deep yellow, and its spectrum shows two well-marked absorption-bands in the blue. When this solution is agitated with water, no colour is dissolved from it, but on adding a little ammonia the greater part of the colouring matter passes to the water in the alkaline modification, of orange colour, giving two well-marked absorption-bands between the blue and the green part of the spectrum, corresponding exactly to the two bands in No. 2, fig. 1, which are nearest to the blue end. On adding a little citric acid that on the green side is removed, and another developed still nearer to the blue end than the one which remains nearly in the original position. If the crushed Aphides are kept longer and treated in the same manner, we

[1] 'Quart. Journ. of Micros. Science,' x, 1870, pp. 400—402.

obtain a spectrum with three bands, analogous to No. 2, fig. 1; and after they have been kept crushed and damp for half a day, the spectrum shows only two bands, which lie so much farther from the blue end than in the former that the band nearest to it in this case almost coincides with that farthest from it in the other. On agitating this solution with water and a little ammonia, the colouring matter is deposited as a pink layer between the ether and the water, the alkaline modification of this substance thus differing from that of the former in being insoluble in water as well as in ether. Separating it and mixing in alcohol it gives a spectrum with two well-marked absorption-bands in the green and green-blue, corresponding exactly with the two bands in No. 2, fig. 1, which lie towards the red end; and on adding a little citric acid the band in the green disappears, and another is developed in the blue. There is thus good evidence to show that the variation in the relative intensity of the bands in spectrum No. 2 of fig. 1 is really due to a variable mixture of these two substances. Both are of yellow colour when the solution is neutral, and when dry are of waxy consistence. They are manifestly formed by an alteration of the original Aphideine, and therefore it may perhaps be well to call the former *Aphidiluteine*, and the latter *Aphidiluteoleine.* On still further exposure to the air a red colouring matter is formed, which may be distinguished by the name of *Aphidirhodeine*; but this may be more conveniently obtained pure in the manner described in the sequel.

As in the case of all such substances, their spectra are best seen when they are dissolved in bisulphide of carbon, for then the absorption-bands lie farther from the blue end, and there is no chance of there being any variation in their position, owing to any difference in the amount of water that may be present in alcohol or ether. When carefully picked out living Aphides are crushed up in a test tube with the bisulphide, the colour is at first red, but almost immediately changes to yellow; and on stirring them up so as to expose to the air and to the bisulphide, the original Aphideine is rapidly altered into Aphidiluteine, which dissolves in the liquid, giving a bright yellow solution. This should be filtered and examined at once. The spectrum of transmitted light shows two well-marked absorption-bands in the blue, situated much nearer to the extreme blue than those of any other analogous substance which has come under my notice. It is also very fluorescent, of a fine green colour, and this light of fluorescence gives the spectrum shown in No. 4 of the following woodcut, fig. 2:

Fig. 2.—*Spectra of the Light of Fluorescence.*



The whole of the green part of the spectrum is seen, with the exception of two somewhat faint bands, which I believe are due to the Aphidiluteine itself, but am not quite certain, since it rapidly changes into other compounds which have absorption-bands nearly in the same situation. On keeping the above-named solution for some hours it is completely changed. The spectrum of transmitted light shows two absorption-bands situated very considerably further from the blue end than before, and the light of fluorescence is yellow-green, giving the spectrum No. 5 with a bright band nearly in the centre of the green and a fainter between the green and yellow. This change takes place much more slowly in the case of the solution in ether, but much more rapidly when crushed insects are exposed to the air, and a third compound is formed, which may be obtained in a very satisfactory manner by digesting dead insects, kept dry for some weeks, in a solution of bisulphide of carbon in alcohol, and after it has remained for a few days agitating the clear solution with excess of the bisulphide. This sinks to the bottom with the greater part of the required substance, and leaves various impurities dissolved in the alcohol. After washing with more alcohol, the solution in bisulphide when evaporated leaves an oily or waxy substance coloured brown orange. When dissolved in bisulphide of carbon this gives most remarkable spectra. The transmitted light is of an orange-red colour, giving five well-marked absorption-bands, one in the orange, dark, narrow, and well defined; one at the yellow end of the green, very dark and well defined, with some general shading on the green side; a third and a fourth, less

dark than the above two, one nearly in the centre of the green and the other at the green end of the blue, whilst the fifth is nearly in its centre. This spectrum is not only remarkable for the number of bands thus spread over so large a space, but also for the manner in which they are related to one another. This is much like what might be due to a mixture of two substances, and yet there is no further evidence of its being so.[1] The solution is strongly fluorescent, the light of fluorescence is orange-coloured, and its spectrum is as shown by No. 6. The yellow, green, and blue are entirely absent; there is a red band, but it is comparatively so faint that the light may be said to be nearly monochromatic, being almost entirely due to the well-defined orange band shown by the figure, which is so narrow that it is only about $\frac{1}{50}$th part of the whole visible spectrum of daylight. As will be seen, it is quite on the red side of the sodium line D, but when the substance is dissolved in ether instead of bisulphide of carbon, the centre of the bright band almost exactly coincides with D, and all the various bands in the other spectra already described are raised to about the same extent towards the blue end, when ether is employed as the solvent.

On agitating the solution of this Aphidirhodeine in ether with water containing a little ammonia, the greater part of the colour is deposited as a green layer between the water and the ether, as though the alkaline modification were insoluble in both water and ether. Separating this and mixing it up in dilute alcohol it gives the spectrum No. 3 of fig. 1, and this fact led me to think it probable that the substance which gives these bands, formed on exposing a solution of aphidieine to the air, is really Aphidirhodeine remaining in a state of very unstable solution. I therefore added to such a preparation two or three times its bulk of alcohol, and on agitating with excess of bisulphide of carbon obtained a red solution of Aphidirhodeine with some Aphidiluteoleine. It therefore appears that though the products derived from Aphideine are not dissolved by water, they may in some cases remain in solution for a time, so as to give a more or less clear liquid. I specially mention this because as an almost universal rule colouring matters soluble in water are insoluble in bisulphide of carbon, or in fats and oils; and misled by the apparent solubility in water, it was some time before I discovered that this brown, dirty-looking solution was in great measure coloured by the clear red and highly fluo-

[1] See my late paper, "On the Examination of Mixed Colouring Matters," 'Monthly Micros. Journal,' vol. vi, pp. 124—134.

rescent substance obtained as already described by the use of bisulphide of carbon, for on superficial examination they seem to have so very little in common.

As already named, when the living insects are crushed up in ether, a small quantity of a yellow colour is obtained analogous to that in the fat or wax of other insects, but no Aphidiluteine, which, therefore, appears not to be a normal constituent. If the insects be killed by exposure for a short time to the vapour of bisulphide of carbon, and the colouring matter dissolved out by ether in the course of a few minutes, the amount of Aphidiluteine obtained is very small; but, if the insects have been kept dead for a quarter of an hour, there is no difficulty whatever in proving that a considerable part of the Aphideine has changed into Aphidiluteine even in so short a period of time. After having been kept dead for about a day very little unaltered Aphideine remains. On keeping them much longer they turn darker and transmit red light, showing the absorption bands of Aphidirhodeine. These facts clearly prove that in such inquiries it is most important to decide whether the colouring matters are or are not present in the living insects. The change from Aphideine to Aphidiluteine is so rapid that I was for a considerable time led to conclude inaccurately that Aphides contained a waxy substance coloured yellow by that compound. Such an instance of rapid and remarkable changes may be rare, but at the same time it serves to show the importance of our taking into consideration the possibility of its occurrence, even when circumstances are not so favorable for deciding the question. When exposed to the vapour of ether, though apparently killed, the insects sometimes revive, and, even if they do not, the Aphideine changes far more slowly, which may explain why bisulphide of carbon has a so much more poisonous action.

Since it may, perhaps, be convenient for reference, I here subjoin a table of the character and position of the more important absorption-bands seen in some of the spectra roughly described in this paper, making use of the notation explained in a previous communication.[1]

TABLE OF SPECTRA.

Fraunhofer's lines, D *is at* $3\frac{1}{2}$ *and* F. *at* $7\frac{1}{2}$.

1. As dissolved in water:

Aphideine, alkaline	$3\frac{1}{2}$ . . . . $8\frac{1}{2}$
„ acid	6 . . 7 - - 8—

[1] "On Some Technical Applications of the Spectrum-microscope," 'Quarterly Journ. of Micros. Science' (N.S.), Vol. IX, pp. 358 and 359.

The first mixed product :					
When alkaline varying as thus shown			$5\frac{1}{8}$	7	$8\frac{1}{2}$
			$5\frac{1}{8}$	$6\frac{7}{8}$	$8\frac{1}{2}$
When acid			$7\frac{3}{8}$	$8\frac{7}{8}$	$10\frac{1}{2}$
The second product				$2\frac{2}{4}$	$4\frac{1}{8}$
2. As dissolved in ether, &c. :					
Aphidiluteine in ether				9	$10\frac{5}{8}$
,, in ammoniacal solution of ether in water				$6\frac{3}{4}$	$8\frac{3}{8}$
,, in acid solution of ether in water				$8\frac{3}{4}$	$10\frac{1}{2}$
Aphidiluteoleine in ether				$7\frac{1}{2}$	$9\frac{1}{8}$
,, suspended in dilute alcohol with ammonia				5	$6\frac{1}{2}$
,, ,, ,, ,, citric acid				$7\frac{3}{8}$	9
Aphidirhodeine in ether	$3\frac{1}{2}$	$4\frac{3}{8}$ ... 5	6	$7\frac{5}{8}$	$9\frac{1}{4}$
,, suspended in dilute alcohol with ammonia				$2\frac{3}{4}$	$4\frac{1}{8}$
3. As dissolved in bisulphide of carbon :					
Aphidiluteine				$8\frac{1}{2}$	$10\frac{1}{4}$
Aphidiluteoleine				$7\frac{1}{8}$	$8\frac{3}{4}$
Aphidirhodeine	$3\frac{1}{4}$	$4\frac{1}{8}$ ... $4\frac{3}{4}$	$5\frac{3}{4}$	$7\frac{3}{8}$	9

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ON THE

NEPHILA PLUMIPES:

OR

SILK SPIDER OF SOUTH CAROLINA.

BY BURT G. WILDER, S.B., M.D.,
Late Surgeon 55th Mass. Vols.

From the Proceedings of the Boston Society of Natural History,
October 4, 1865.

ON THE

NEPHILA PLUMIPES:

OR

SILK SPIDER OF SOUTH CAROLINA

NOTE. For more or less extended accounts of the different parts of this subject, see Proceedings of the American Academy of Arts and Sciences for Nov. 14th, 1865; Proc. Bost. Soc. Nat. History, Oct. 11th and Dec. 6th, 1865, and March 7th, 1866; and Proc. Mass. Inst. of Technology, Jan. 18th and Feb. 1st, 1866.

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*While this was passing through the press I found in the Astor Library, New York, a copy of a rare Italian work by R. M. de Termeyer, entitled "Richerche e sperimenti sulla seta de Ragni," in which is described his process of obtaining silk directly from spiders. But no allusion is made by others, to either the idea or the book itself, which was published about 1800. I find also that in Jones' "Naturalist in Bermuda," 1859, page 126, is described an experiment of the author for ascertaining the strength of the silk of *Epeira* (*Nephila*) *clavipes*, by drawing the silk out of its body.

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By a letter written on the 20th of August, 1863, from the camp of the 55th Mass. Vol. Inf., at the north end of Folly Island, South Carolina, I find that "on that day I caught a large and very handsome spider, from which, as it stood quiet near the top of my tent, I wound off silk upon a quill for an hour and a quarter, at the rate of six feet per minute, making four hundred and fifty feet or one hundred and fifty yards."

This silk is still in my possession, but has been removed from the quill for the purpose of ascertaining its weight, which is one-third of a grain. I had never heard of this method of obtaining silk; neither had I ever seen or read of such a spider; but, though this specimen was not preserved, I was so impressed with its size and the peculiar aspect given by the brushes of stiff hairs upon the legs, that when, during the following summer, another officer* of our regiment described to me a large spider very common upon Long Island, which lies just west from Folly Island, I knew it was the same species and told him what I had done, adding that I was "sure something would come of it sometime." By substituting a cylinder worked with a crank, for mine turned in the fingers, this officer obtained more of the silk, which he wound in grooves cut upon rings of hard rubber, and in other directions upon the sides of such rings; while another officer;† by employing a "gear drill stock" with cog-wheels, accomplished similar results still more rapidly; on the first simple machine I wound off silk into two grooves cut in the periphery of a hard rubber ring, parallel except at one point where they crossed to form a kind of signet, the silk being guided at this crossing by a pin upon a pivot moved by the hand at each revolution of the ring; and on the "gear drill stock" upon a larger ring one inch in diameter and three-eighths of an inch in width, in a groove upon its periphery one-fourth of an inch in width, and across the sides of the ring in two directions, I wound *three thousand four hundred and eighty yards*, or *nearly two miles of silk*. This length was estimated by accurately determining the different dimensions of the ring where wound upon, and multiplying by this the number of revolutions of the cylinder per minute (170), and this product again by the number of minutes of actual winding (285), having deducted from the gross time of winding (about nine hours), each moment of stoppage for any cause.

This was in the autumn of 1864, and so the matter rested till Feb. 1865, when, preparing to present the subject to the Society, I showed specimens of the spider and silk to Professors Wyman, Agassiz, and Cooke of Harvard University, to all of whom both the species of

* Major Sigourney Wales, 55th Mass. Vols.

† Lieut. Col. Chas. B. Fox.

spider and the kind of silk were entirely new* as was also the idea of reeling silk directly from it or any other insect.

At this time too, a friend † to whom the whole history of the matter was known, expressed his confident belief that this new silken product could be made of some practical utility, especially in view of the anticipated scarcity of the ordinary silk; and it is with his advice and assistance that the experiments and investigations recounted below have been made as far as our limited time and means have allowed.

On the 30th of August, 1865, I obtained from Long Island some living specimens, chiefly females, and have succeeded in bringing a few of them to the North.

I find no mention of this spider in the works of Hentz or any other American entomologist, which may be the result of its being very circumscribed in its locality to a small and unimportant island; but in "Die Arachniden," by C. L. Koch, Vol. 6., is a figure of a mutilated female specimen, the only one ever collected, and said to have been found in Louisiana, which was preserved in the Museum of J. Sturm at Nuremberg.

The description and figure of this specimen are so unsatisfactory that I am really in doubt as to its identity with the spider under consideration, but will provisionally regard the latter as the *Nephila plumipes*, hoping at some time to settle the point by an actual comparison with the unique specimen described by Koch.

I append here a description and figure of the spider drawn from living individuals.

Nephila plumipes Koch.

A large and very elegant species, resembling most of its congeners in the general form of the body, and like *N. clavipes* and *N. fasciculata* possessing peculiar collections of stiff hairs upon the legs, but differing from them in that these hairs are more closely set together, so as to justify the German term "Häarbürste" (Hair brushes).

The cephalothorax is black above, but covered, except in spots, with silver-colored hairs. The abdomen is olive-brown variously marked with yellow and white spots and stripes. On the 1st, 2d, and 3d pairs of legs are one or two brushes of stiff black hairs, pointing forward away from the body. The length of the body is from 1 to 1.10 and the spread of the legs 2.75 in a lateral, and 3.75 inches in a longitudinal direction.

The above applies only to the female, which will now be more minutely described; the male is very small and differently marked.

* Prof. Wyman has since found among his alcoholic specimens of insects collected in the South, one female individual of this species, but is not certain of the precise locality in which it was obtained.

† Dr. William Nichols of Boston.

The entire upper and anterior surface of the cephalothorax is jet black, but behind the eye-spots it is thickly covered with little white hairs, except in six spots, three upon each side over the origins of the three anterior pairs of legs; the first pair of spots being the largest and pointing obliquely forward and outward. The edges of the cephalothorax are reddish-brown. The eye-spots are black and eight in number, four in the centre in form of a square, and two upon each side, one above and one below a rounded elevation. The falces are black. The abdomen above is light yellow. On each side of the middle line are six silvery spots, of which the 1st and 3d pairs are the largest, then the 2d, 4th, 5th, and 6th; the three anterior pairs are rounded, the others flattened laterally. On the middle line between the 1st and 2d pairs, and again between the 3d and 4th pairs, the pulsations of the dorsal vessel are visible; besides the larger spots there are many smaller ones irregular in size, shape and position, but more numerous anteriorly. The anterior edge of the abdomen is olive-brown; in front of and below it is a silvery cross stripe semilunar in shape, the horns pointing backward; and just behind it is a similar stripe.

The sides of the abdomen are lighter than the top and the spots are generally silver-colored and oblong, especially in the line of the horns of the above mentioned white stripe. The lower surface is still darker than the sides, but the anterior third is a hard and horny plate with a free posterior edge covering the generative orifice. The surface of this is by its coloring divisible into three sections, one median and two lateral, each of which is again composed of a broad anterior and a narrow posterior portion. The anterior median portion is brown and depressed between the lateral portions, which are black and slightly punctate and bordered internally by a yellow, and externally by a dull reddish stripe; the posterior median section is dark brown, raised and quite convex, while the lateral portions are dull red and flat, with sharp posterior edges.

The middle third of the lower surface of the abdomen is dull red without spots and separated from the sides by yellow stripes or series of spots, and from the posterior third by several yellow spots; this third is also dull red and without spots, but not so distinctly separated from the sides; behind the posterior third, and forming its boundary, is the group of spinnerets, or mammulae, of which there are two principal pairs, anterior and posterior. Between these and concealed by them is a very small pair, the nature and use of which I have not yet ascertained. In color the mammulae are dull red, but the apices are surrounded by short black hairs; behind the spinners and enclosed in the same fold of integument is a median papilla through which the excrement is voided. The posterior surface of the abdomen is flattened, and re-

sembles the sides in color and marking. The lower surface of the cephalothorax is shield or heart shaped, black in the centre but dull red at the sides.

The 1st and 2d segments (shanks) of the limbs are dull red; the 3d segment (thigh) is dirty yellow, but in the first, second and fourth pairs the distal third is dull red, and covered with a brush of stiff black hairs; the depth of the color and the size of the brush decreases from the first to the fourth pair; the thigh of the third pair is perhaps a shade darker where the brushes are upon the others. The 4th segment is dull red in all the legs; the 5th is, in all, dirty yellow as to its proximal portion (a little less than half) while the distal portion is dull red. In the third pair it presents a few scattering black hairs, but on the other three pairs there is a hair brush like that upon the thigh, completely encircling the limb, but the hairs are set a little more nearly at right angles with the surface. There are also a few black hairs on the under side just at the junction of the 5th with the 4th segments, and in the third pair a few in the place of the hair brushes on the others. The proximal portions, (again less than one-half) of the 6th segment (1st of the foot) is dark dirty yellow and the distal portion, with the 7th segment, is dark dull red, or nearly black, and both segments are covered with short black hairs. Upon the proximal yellow portion of the 3d and 5th segments are very fine short hairs, with a few longer ones intermixed.

The outer half of the maxillæ is dirty yellow, the inner half, with the 1st segment of the palpi, dull red; 2d segment dirty yellow and covered by very small black hairs, the 3d segment is dull red, likewise the 4th and 5th, the latter being nearly black and thickly covered by black hairs.

Of the eight eyes, the four intermediate ones form a square, and are set at the four corners of a prominence; the lateral eyes are set upon the extremities of two more oblique tubercles, those of each pair being separated from each other by more than their own diameter, and looking, the one downward and forward and the other upward and backward.

The body of the male is one-fourth of an inch in length, and his legs spread less than one inch in a longitudinal and three-fourths of an inch in a lateral direction. The general color of both body and legs is dark-brown, the former presenting a median dorsal stripe of a darker color, and the latter a few scattering black hairs, but no such brushes as those of the female. His palpi are strongly clavate at the middle of their length and end in a sharp point turning outward.

I have never, during a two years' stay on the coast and in the interior of South Carolina and Florida, met with any traces of this spider elsewhere than near Long Island; nor, with the exception of

the first specimen found upon Folly Island, and a cocoon found in a tree on James Island, have I seen it upon the adjoining islands, though there seems no reason why it should not also occur all along the seacoast.

Long Island is a low, narrow, uninhabited strip of land about five miles southwest from Charleston, surrounded on all sides by creeks and in the midst of a great salt marsh. The spiders are found in the forest, building their webs between trees and shrubs, sometimes within reach, but more often ten or fifteen or even more feet from the ground so as to be reached by the sun. The web is very large, from three to four feet in diameter, quite strong and very viscid; its yellow color is seen in the sunlight, or when the web is gathered into a mass. It is composed of two kinds of silk, of which one is white or silver-gray, inelastic and perfectly dry; the other is of a bright yellow or golden hue, very elastic and studded with little globules of gum which render it exceedingly adhesive; the *frame-work* of the web, namely, the guy-lines or stays and the diverging lines or spokes of the wheel-shaped structure, is all composed of the former or silver colored, dry and inelastic silk, while the concentric circles which serve for entangling the prey are composed of the latter, or golden, elastic and sticky silk; these circles are very numerous, being generally less than one-third of an inch apart, but for the further strengthening of so large a web, between every eight or ten* such circles occurs one of the silver colored silk; these latter are made before the viscid lines, but neither of them are in the web of this species spiral, as in the web described by Blackwall and others,† on the contrary they seldom if ever, form complete circles, but are looped and return in the opposite direction into a corresponding point at the other side of the web, leaving above the centre a space occupied only by radii through which the spider can pass to either surface of her web, the greater part of which, therefore, is below the point where the radii converge, the dry lines are not destroyed on the completion of the web, but remain and seem necessary for its stability.

As might be inferred from these facts this spider not only has the power of regulating the *size* of its thread, according as one or two, or three, or four of its mammulæ are pressed upon the surface from which the line is to extend, or as a greater or less number of the spinnerules in any mammula are employed; but can also use in the construction of its web, either the white or the yellow silk at will; for of its two principal pairs of mammulæ, one, the anterior, yields the *yellow*, while the other or posterior pair yields the *white* silk. Of this I satisfied myself

*The number varies according to the individual and even in different parts of the same web.

† Zoölogical Journal, Vol. V., p. 181.

by carrying the thread from the anterior pair of mammulæ upon one part of a spindle and that from the posterior pair upon another, guiding them with pins while the spindle was in motion; the result being the formation of two circles of silk, one of a golden, the other of a silver color, as in one of the specimens exhibited; morever, if while both threads are being drawn out, they are slackened, the lower silver thread will wrinkle and fly up, being inelastic, while the other will contract and, within certain limits, preserve its direction. At that time the existence of a smaller pair of mammulæ intermediate between the other two, was unknown to me, and it is possible that the yellow line proceeded from them, and that both the larger pair yield the white silk. Most of these experiments were made in the field under unfavorable circumstances and will be more accurately repeated.

The careful dissection of an alcoholic specimen will readily discover the organs from which this silk proceeds, and which have been described in other species by several authors; the preparation exhibited to the Society shows one set of silk-glands consisting of six elongated yellow bodies, more or less convoluted and measuring about one-third of an inch in length, lying under the integument of the lower surface of the abdomen, three upon each side of the middle line; the excreting ducts, one for each gland, are also plainly visible. But beside these, there are to be found at least four more glands, of which one pair shorter but thicker and larger, and also of a yellow color, are located in the upper and anterior angles of the abdomen; while the other two glands are white, or transparent, and lie nearly in the center of the abdomen; the ducts of all these glands are easily traced to the region of the spinnerets, but I have not yet observed the precise mode of their termination. It will be noticed that the yellow silk is secreted in greater abundance, as also that it is more extensively employed in the construction of the web.

All these glands contain a semi-fluid and very viscid gum which may be drawn out into threads of variable diameter; these however, being single and not, like those spun by the spider, minutely compound, break up on being sharply bent.

A familiar, but thus far unexplained, fact is, that while the yellow thread as spun by the spider in its web is so exceedingly viscid on account of the numerous globules of gum with which it is studded, as to follow the point of a pin, this same yellow silk when reeled from the insect, whether slowly or rapidly, and also when employed by the spider to form the cocoon about her eggs, is perfectly dry and much less elastic and yielding, though still more so than the white variety. I have put several specimens under the influence of chloroform which apparently has no effect upon the evolution of silk.

I have never been able to reel above three hundred yards of silk from

a spider at one time; but this evidently does not exhaust the supply, for on opening the abdomen the glands are still partially filled and the following day a quantity equal to the first may be obtained; this I did upon three successive days, so that, if, as now seems probable, the emission of the silk is mainly mechanical, then a certain degree of preparation is necessary after it is secreted before it is ready for use.

The diameter of the silk as spun by the insect or as reeled from it, varies from $\frac{1}{6000}$ to $\frac{1}{1000}$ of an inch; * it is exceedingly strong, but I have not yet been able to accurately determine its strength as compared with fine ordinary silk. The largest threads are those composing the outer layer of the cocoons, but these are evidently compound, and the two, three or four strands are apparently such as proceed from the single spinners, the minute fibrils of which have united at once on leaving the spinnerules so as to form the ordinary silken fibre which generally appears simple under the microscope.

Having completed her web, the female stations herself at its centre head downward, waiting for prey; the diminutive male (they are not constantly present) preserves a respectful distance from her, and, as far as I have seen, never attempts to do anything for himself, except of course the impregnation of the eggs; he builds no web and catches no prey; and while she is moving from place to place, or even while making her web, he gets upon the upper or lower side of her abdomen holding on with his legs and darting about to keep out of the way of hers; for she seems to pay no attention to him and might easily do him an injury even by accident.

On one occasion I saw a male stray away from his proper home to an adjoining web, from which, however, he was speedily driven by the indignant female possessor, with the loss of two of his legs; of which injury he shortly afterwards died.

In the webs of these spiders are found insects of all kinds, even the largest and most vigorous, such as the great cicada of the South. When anything strikes the web, the spider instantly starts, and, if the vibrations indicate that it is suitable for food she rushes to it and seizing it in her powerful jaws holds on till it is dead; after which she throws a net around it and carries it to a place where she can devour it at her leisure; in this respect unlike some other geometrical spiders, of which one species, common on James Island, S. C., never attempts to seize the prey with the jaws till it has first dexterously spread a net over it by turning it over and over with the first and third pairs of legs and, with the fourth pair, used alternately, drawing out the silk as a broad white band.

But if the violent struggles of the prey show it to be of large size, then our spider advances with caution, feeling with her anterior legs,

*The micrometer measurements were made by Mr. R. C. Greenleaf.

and if satisfied that she can do so with safety, will suddenly close with the victim; but if not, or if some foreign body is placed in the web, then she will snip off with her jaws every line which supports it till it drops to the earth; this I saw done by several spiders, which had made their webs in my room in South Carolina, with a dead snake six inches in length.

It is remarkable, that although these spiders possess eight eyes and can evidently distinguish light from darkness, yet, so far as my observation goes, they cannot *see* anything at all whether near or remote; they pay no attention to an object put close to them nor to the quiet movements of any one about them, and will often rush by an insect entangled in their web if it chance to cease its struggles before the spider has accurately determined upon its position; it will then slowly return to the center of the web and wait till another vibration indicates the whereabouts of the insect; a fly offered to it upon the point of a needle will not be noticed till it begins to buzz, when it will be seized at once; the hearing and touch are evidently very acute; the organ of the former sense is not known; the latter is exercised by the palpi and by the extremities of all the legs, especially those of the first pair, which are continually used as feelers. How acute the sense of smell is I do not know.

This spider is remarkably quiet in its habits, never leaving its web unless disturbed in some way, and it bears handling better than any species with which I am acquainted. That it can bite is evident from the size of the jaws and the firmness of their hold, and that the venom is active is shown by the speedy death of its victims;* but they never attempt to bite unless provoked, and may be allowed to run over one's flesh with impunity, care being taken not to remove them from it suddenly or roughly for they are apt to hold on with the jaws when the grasp of the legs is not sufficient. The length and comparative weakness of the legs renders it easy to put this spider in the only position in which any spider can be safely handled, namely with all the legs held behind the back. In their webs they are active and surefooted, but slow and awkward on the ground or any plane surface. They always prefer the light, and construct their webs where the sun can reach them; the young manifest the same instinct and always seek the sunny side of a glass vessel containing them; they also keep the

*Blackwall, (Linn. Transactions, Vol. xxi. page 31-37) recounts experiments to support his opinion that the bite of the larger British species causes no more injury to man, to other spiders, or to insects than an ordinary puncture or laceration of equal extent and severity; and the same author in his Spiders of Great Britain and Ireland, Part 1, p. 2, does not even mention the word *poison* in speaking of the colorless fluid emitted through the falces, but although we seldom hear of well authenticated cases of injury from the bite of a spider, it would hardly be safe to suppose all of them harmless.

head downward and will instantly turn over if the vessel containing them be inverted.

The eggs are laid in a rounded, or flattened mass about one half an inch in diameter; they are .04 to .05 of an inch in diameter, white and at first slightly agglutinated together, but become yellowish and easily separable as the time for hatching arrives, which, in the case of some eggs laid this fall was in about thirty days; the young spiders are yellow with whitish legs, which however soon become darker in color while the abdomen presents some faint markings on its surface; some have cast one skin within a few days and can spin a thread within a week after leaving the egg; but of their own accord they do not leave the cavity of the cocoon for some time, during which, as far as I know, they take no food, excepting perhaps that they devour one another, but seem to undergo an increase of the legs and cephalothorax at the expense of the abdomen; but for some reason, whether on account of the elements, or birds, or other insects, or the attacks upon one another, I cannot say, only five or six out of the five or six hundred hatched in any one cocoon ever come to maturity in the natural state.

The mass of eggs is enclosed in a loose silken cocoon, the threads of which are very large and strong, especially the outer ones, which are $\frac{1}{1000}$ of an inch in diameter while the interior ones are $\frac{1}{2000}$ of an inch in diameter; this cocoon weighs from .320 to .655 of a grain.

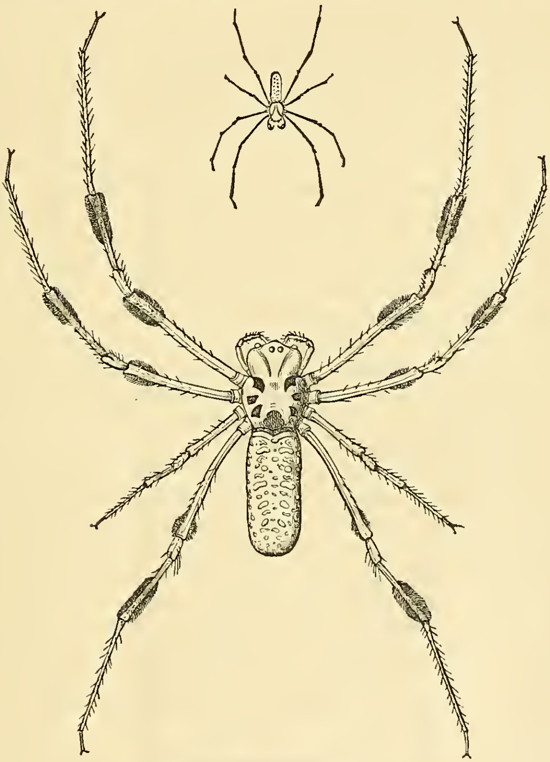
The grown females, which I have kept alive for one month or more, in boxes or in webs constructed in my room in South Carolina, have all readily taken, from the point of a needle, live flies or bits of fresh chicken's liver, from which they suck the juices; they likewise take water from the point of a stick or hair pencil, holding the drop between the palpi and the jaws while it is slowly swallowed; one spider has thus taken six drops of water in succession.

Much more might be related concerning the habits of the insect, of the manner of keeping and feeding the young, of the means of securing the spider while its silk is obtained, and of the various apparatus employed; but I am so impressed with the peculiarities thus far observed in themselves, and with the beauty and strength of the silk that if time and means permit, I shall continue the inquiry as far as possible, and will defer to a future occasion a more complete account of the spider, its habits, anatomy and embryology, and of the various qualities of its silk, with whatever conclusion can be reached concerning the practicability of rearing the young, and also how far it is possible to apply the same method of extraction to the silk worm, and other silk-producing larvæ.

NOTE. April 2d, 1866. Some of these spiders, hatched in October, 1865, are now more than an inch in length.

It is but recently that I have had the benefit of an acquaintance with the investigations of others upon the economy of the geometrical spiders; and in the entire absence of any American works on this subject, I will refer to the memoirs of Blackwall and other British naturalists published in the Linnæan Transactions, Vols. xvi., xviii., and xxi., in the Zoölogical Journal, Vols. iv. and v., in the Transactions of the Entomological Society, Vols. i., ii., and iii.; Entomological Magazine, Vols. ii. and iii., and Reports of the British Association for 1844 and 1858. The earlier papers are quoted in Kirby and Spence's Entomology, while a brief synopsis of nearly all is contained in the introduction to Part 1. of Blackwall's Spiders of Great Britain and Ireland, published by the Ray Society in 1861 and 1864.

Many of these opinions have been confirmed by my observations upon the *Nephila plumipes*, and where it is otherwise stated, the differences may sometimes (as with the construction of the webs, mentioned above) be in consequence of specific peculiarities.



Nephila plumipes Koch.
The smaller figure, the male; the larger, the female.

[From the Proceedings of the Entomological Society of Philadelphia.]

Descriptions of several new species of CYNIPS, and a new species of DIASTROPHUS.

BY H. F. BASSETT.

QUERCUS RUBRA. *A cluster of forty or fifty elongate-ovate galls on a branch of a young red oak tree. They are from three-fourths of an inch to an inch in length, and a half an inch in diameter in the middle, tapering to a point at the ends; covered with a short, velvety pubescence, and when dry, ridged like a melon; the inside, a cork-like substance adhering closely to the larval cell, and divided lengthwise into many parts like the dissepiments of the seed-vessels of various kinds of plants; monothalamous—the cell one-tenth of an inch long.*

C. q. formosa n. sp.

♀. Head black. Head and face finely and evenly rugose. *Antennæ* 15-*jointed,* yellowish-red, the terminal joints darker. The suture between the 14th and 15th as distinct as the preceding ones; face with a short pubescence, the hairs converging towards the mouth; mandibles black, palpi yellowish-red. *Thorax* black; a few short hairs on the collare; *mesothorax:* parapsidal grooves distinctly marked, median line broad where it begins on the scutellum, but gradually decreases and disappears just before reaching the collare; between this and the parapsidal grooves two short lines beginning on the collar and extending half way to the scutellum. The thorax and pleuræ are beautifully *ripple-marked with fine short transverse lines.* This style of marking is distinct from that of any of the species in my collection—thirty or more. The same style, only coarser, is seen in some Chalcidians. *Scutellum* small, finely rugose, the small foveæ are smooth and shining. Legs bright brownish-red, except the upper part of the femur, which is nearly black, and the black coxæ. *Abdomen* bright reddish-brown, with an extremely minute microscopic punctation; sheath of the ovipositor a dark brownish-red. *Wings* hyaline, also the veins, except the first and second transverse and the subcostal, which are a very pale yellow; areolet large, equiangular, bounded on the inner side by entirely colorless veins, radial area open. Length .12. ♂ unknown.

The flies have not yet left the gall (Nov. 25) though they have been in the imago state for several weeks, and crawled about actively when the galls were opened. They may be imprisoned by the hard dry gall, but I am inclined to think, that, like some other species, they remain in the galls in the perfect state through the winter and come out early in the spring.

The galls of this species are very rare. I have found only two clusters, and one of these was much eaten by some Lepidopterous larva, and the larvæ of the true gall fly were destroyed. Only a part of the galls in the other cluster were developed as described above; the smallest were not larger than grains of barley, but contained larvæ, and have produced true gall flies. Their diminutive size was owing. apparently, to their being closely crowded.

This and the species next described, *C. q. ventricosa* n. sp., are readily distinguished from any other American species yet described, by the female, (male as yet unknown,) having *fifteen distinct antennal joints.* Dr. Fitch (N. Y. Rep. Vol. 2. No. 309) speaks of having, in his collection, a female gall fly with fifteen jointed antennæ, but he does not describe it, nor the gall from which it came.

Westwood (Syn. Gen. Br. Insects) does not characterize any genus of the family Cynipidæ as having more than the ♀ 14, and the ♂ 15 antennal joints—but the ♂ of my *C. q. singularis** (Proc. Ent. Soc. Phila. Vol. 2nd. p. 326) has 16-jointed antennæ, and *C. q. scitula*—a new species described in this paper—also has the same number. The females of both these species have only 13 joints, the terminal one long and connately divided in the middle.

C. q. formosa and the species next described are evidently closely related, for besides the 15-jointed antennæ of the ♀ there are other points of resemblance; and the remarkable difference in the colors of the two species, the ripple-marked thorax of *C. q. formosa*, and the widely different galls from different species of oak, are the most marked specific characters. The shape of the abdomen of both species is peculiar; different in form, and, I think, in structure, from any other species I am acquainted with, but I have not yet sufficiently studied the structure to describe it well, and have simply, in my description, noticed the vertical diameter as equalling or exceeding the length.

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* Mr. Walsh assures me that my C. q. singularis is the same as C. q. nubilipennis Harris. He is undoubtedly correct, and my name stands, of course, as a Synonym. Dr. Harris' very brief descriptions were definite enough, perhaps, when the number of species was, as when he wrote, very small, but hardly complete enough for the genus to-day. The number of species described and properly belonging to, or provisionally placed in, the genus Cynips, exceeds fifty, and many more will probably be found.

QUERCUS ILICIFOLIA. *Galls growing in clusters from three or four to a dozen together, on the limbs and occasionally on the trunks of young shrub oaks. They are cone-shaped, truncate at the base, the apex often prolonged in a slender, recurved point. They are from four to five-eighths of an inch long, and from one-fourth to three-eighths in diameter at the base. When green, often of a deep red color; when dry, brown or black; very hard, enclosing a nearly free larval cell like that of C. q. globulus, Fitch.*

C. q. ventricosa n. sp.

♀. Head and thorax a bright cinnamon color, head finely punctate, face pubescent, dark brown around the mouth, tips of the mandibles black, palpi pale brown. *Antennæ* long, 15-jointed, third joint longest, others gradually decreasing in length to the 15th, which is as long as the two preceding ones, and shows plainly a connate suture. *Thorax* finely and evenly punctate; parapsidal grooves not deep: the line dividing the mesothorax lengthwise reaches from the collare to the scutellum; each side of this is a line reaching half way from the collare to the scutellum, and marked with an indentation at the posterior end; also a deep linear depression on each side over the base of the wings; pleura microscopically punctate; mesothorax bounded on the sides and where it joins the scutellum by a dark reddish-brown line. *Scutellum* very finely sculptured, a dark and narrow ridge dividing it half the length. Feet yellow, tips of the tarsi black. *Wings* hyaline; the subcostal, anal, first and second transverse veins large, dark reddish-brown; the first two rather paler towards the base; areolet distinct; radial area open, the vein forming its base considerably enlarged. *Abdomen* darker brown than the thorax; segments short, second longest: vertical diameter, i. e. the distance from the back of the abdomen to the ventral edge, equals or slightly exceeds the length; terminal segments show a fine punctation. Length .14. Male unknown.

My galls were collected in June. The flies were found to be fully developed in October. They were cut out, else they would probably have remained in the galls until spring.

QUERCUS ILICIFOLIA. *Elongated, fusiform galls growing on the upper side of the leaves of Q. ilicifolia, and standing erect, or nearly so—sometimes entirely preventing the development of the leaf, and apparently growing out of the petiole. The central nucleus containing the larvæ is kept in place by radiating woody fibres as in C. q. inanis O. S. The largest galls are two inches in length and seven-eighths of an inch in diameter; average size about one and three-fourths inches long, and three-fourths in diameter. Apex rather longer and more slender than the basal portion, and often considerably curved.*

These galls are of the same dark green as the leaves. Many are found very much smaller than those described above, but they produce parasitic flies. Baron Osten Sacken writes me that he met with numbers of these galls in Pennsylvania several years ago. They are rather rare here (Conn.)

Q. q. ilicifoliæ n. sp.

♀ Black, vertex of the head, and the entire thorax black, and deeply and irregularly sculptured; face rugose and pubescent; hairs converging toward the mouth; palpi shining reddish brown. *Antennæ* 13-jointed, the 13th long, and with a false suture apparent on the inner side; first and second joints very short, shining black; the remaining ones pubescent, and dull black. *Thorax* with a coarse pubescence. The parapsidal groove obliterated by the coarse, somewhat linearly arranged sculpturing. Foveæ large but sculptured like the rest of the scutellum. *Feet:* coxæ, and the upper part of the femur of the two anterior pairs black—other parts reddish-brown; posterior pair black, reddish at the joints. *Abdomen* black shining, the ventral edge clear brownish red. The segments, except the first and second, with a very fine microscopic punctation, most apparent on the third segment. *Wings* slightly dusky; veins brownish black, heavy; areolet very small, vein at the base of the open radial area covered by a large brownish black cloud, which covers part of the areolet but does not reach the anterior margin of the wing. A very light brown cloud in the basal cell of some specimens. Length .17.

♂.—Antennæ 15-jointed, feet darker than those of the female; posterior pair, including the tarsi, almost entirely black. Otherwise like the female except the usual sexual differences. Length .14.

Ten ♀ and four ♂ specimens.

QUERCUS ALBA. *Flat, green, succulent galls, often of a very irregular outline, and from one-fourth to more than an inch in diameter, the vertical diameter from one-fourth to three-eighths of an inch, growing on the leaves of the white oak, and producing, according to the size, from two or three, to more than a dozen gall-flies.*

The flies escape from the galls in June, through the upper or under surface. The water that enters the cavities the flies have left causes the galls soon to decay and drop off, but a few change to a dry pith-like substance, and remain on the tree through the summer. These might be taken for a different species, as they generally contain larvæ, but having reared a few Spalangia (?) from such galls, I infer they are all parasitic.

This species is closely related to *C. q. irregularis* O. S. but grows on a different species of oak, and Baron Osten Sacken to whom I sent

specimens, thinks it may be specifically distinct from that species, which I have not yet seen. The imperfect condition of his only specimen of *C. q. irregularis* renders a satisfactory comparison impossible, and acting upon his suggestion, I describe it as

C. q. majalis n. sp.

♀ *Head* transverse, black, nearly smooth, but under a powerful magnifier presents a fine netted appearance; face smooth with a very few short white hairs; mouth brown, tips of the mandibles black. *Antennæ* long, with 13 joints, first and second short, third very long and enlarged at the upper end. These, except the slightly enlarged portion of the third, are a pale yellowish white, the remaining joints a light opaque brown. *Thorax* black, smooth and shining; without any grooves or striæ whatever on the mesothorax. *Scutellum* smooth, separated from the mesothorax by a broad shallow groove; foveæ wanting; marked posteriorly by *two deep transverse grooves,* causing three transverse ridges above the insertion of the abdominal peduncle. *Feet* white with a tinge of yellow, like the basal joints of the antennæ. *Abdomen* black, smooth; in dry specimens shrunken and wrinkled. *Wings* large with a faint duskiness and a dusky cloud resting on the first transverse vein; veins dull brown; areolet present; radial area open, long and very narrow. Length (dry) .09.

♂.—*Head* black; *antennæ* 15-jointed; three basal joints paler than of the ♀: others a semitranslucent brown. Third joint very long, remaining ones short, and of equal length. Third joint curved rather than incised. *Thorax,* the feet and the first and part of the second segment of the abdomen very light yellowish brown. The central part of the mesothorax dark shining brown: terminal segments of abdomen dark brown; in some specimens nearly black. Length .10, slightly longer than the ♀.

Several hundred ♂ ♂ and ♀ ♀.

QUERCUS TINCTORIA. *Woody, tuber-like galls, growing on the green branches of Q. tinctoria, sometimes simply an enlargement of the limb, at others entirely checking its growth and covered with leaves. They are from three-fourths to an inch and a half in length, and rather more than half an inch in diameter at the base, tapering to a cone-like point.*

C. q. scitula, n. sp.

♀. Black. *Head,* vertex black, subrugose; sides of the head and the face in some specimens a very dark brown, with a shade of red, but most are a dull brownish black: face pubescent. *Antennæ* 13-jointed, the 13th long and in the middle connately divided; the basal joints yellowish-brown, the terminal dark brown, the transition gradual. *Thorax* finely and regularly punctate; parapsidal lines fine, and two parallel interparapsidal lines so faint as to be seen only in certain positions to the light, median line merely a longitudinal depression, a short deep groove over the base of the wings. *Scutellum* regularly and finely sculptured; basal pits obsolete. *Feet* shining yellowish-brown. Middle of the

femur and tibia darker than the joints, tarsal tips black. *Wings* hyaline, 1st transverse and radial veins dark brown, others pale but distinct: areolet of medium size and at the base of the open radial area. Length .09.

The ♂ closely resembles the ♀ in color and markings. The abdomen is very long, and the antennæ a rich amber color, with a few of the terminal joints of a light brown. In all the specimens I have examined (16) the *number of antennal joints is sixteen.* Length .08.

Numerous ♀ ♀ and 25 ♂ ♂.

Dr. Fitch has given a very correct figure and description of the gall of his *C. q. batatus*, which, it will be seen, closely resembles that of the above species. Indeed there is little or no apparent difference in the galls more than pertains to the different species of oak on which they grow, but the flies are very distinct. As Dr. Fitch describes the fly so very briefly that it may easily be confounded with *C. q. scitula*, I give a more full description below:

Quercus alba.

C. q. batatus Fitch. (N. Y. Reports, Vol. 2nd, No. 311.)

♀ Black, shining, entire head black, vertex smooth; face, covered with a fine thin pubescence; color of the palpi, clear vitreous brown. *Antennæ* 13-jointed, first three joints pale yellow, others a pale semi-translucent brown. *Thorax* black, shining, but under a powerful magnifier shows a net-work of fine lines; parapsidal grooves and striæ obsolete. *Scutellum* smooth, polished; a few scattered hairs on the posterior portion; basal pits wanting; separated from the mesothorax by a deep shining groove. *Abdomen* black and polished but in all my dry specimens contracted and wrinkled. *Feet,* coxæ clear yellowish brown, femur, in the middle dark brown or black, as is also the tibia of the posterior pair; remaining portions, except the tips of the tarsi which are black, are of the same color as the coxæ. *Wings* hyaline, all the veins dark brown and of nearly equal size. The cubitus large and heavy its whole length: areolet large; radial area open. Length .09.

♂.—The antennæ of the male is 14-jointed. Feet dull pale yellow. Abdomen petiolate by the elongation of the first segment. Length .08.

Numerous specimens ♂ and ♀.*

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*I am satisfied that there are annually two generations of *C. q. batatus.* The first appears early in May, from galls of the preceding year's growth,—the last late in June, from green galls. I have often found perfect insects in the galls in winter, and have reared flies from them, apparently of the same species reared from the summer galls. Inquilinae in great numbers are produced from the winter galls and few true gall flies, while the reverse is true of the summer form. As many of the summer galls remain green after the flies have left them, and as the tree's annual growth is nearly or quite complete the first of July, it

Quercus ilicifolia. *Club-shaped, woody galls, growing on the ends of the small limbs. Apex blunt and generally turned to one side, covered in summer with a few leaves and containing one, and occasionally two or three larvæ. It is strikingly like that of C. q. tuber of Fitch, but produces a fly which though closely related, is evidently a different species.*

C. q. similis n. sp.

♀. Head and thorax a bright brownish red; vertex of the head finely sculptured; the rather prominent ocelli are black only at the apex, face pubescent: hairs short, converging towards the mouth. *Antennæ* 13-jointed, the 13th nearly as long as the two preceding ones and in some individuals there is an obscurely marked connate suture. *Thorax* coarsely punctate, sparsely hairy, a shade darker than the head, three faint longitudinal lines reach from the collare to the scutellum, and two other lines, one on each side and very close to the median line, start from the collare and extend half-way to the scutellum; obscure line over the base of the wings. *Scutellum* sculptured, basal pits small, deep and smooth. The central portion of the pleura—in many species smooth and polished—is in this covered with very fine longitudinal striæ. The legs of a uniform brownish red, except the tips of the tarsi which are black. *Wings,* a subopaque white, the subcostal, anal, 1st and 2nd transverse very pale yellow, others colorless and the *vein which bounds the posterior side of the radial area in other species is, in this obsolete, as is, also, the cubitus and areolet. Abdomen,* red, except the dorsal portion of the middle segments which is nearly black; terminal segments withdrawn into the others in dry specimens, and the sheath of the ovipositor turned abruptly upward but does not extend above the back of the abdomen as in the Inquilinæ. Length .12.

♂. Black head and thorax. *Antennæ* 15-jointed, 1st and 2nd joints nearly black, others red. *Legs,* posterior pairs dark reddish-brown, the posterior pair dark brown, nearly black—all lighter at the joints. *Abdomen* black and shining, 2nd segment long. It is much smaller than the female. Length .08.

16 ♀, 4 ♂ specimens.

C. q. tuber Fitch. (N. Y. Rep. Vol. 2nd, No. 309.)

♀.—Head black, sides, however, in a strong light have a tinge of red; face black, pubescent, hairs converging towards the mouth *Antennæ* yellowish-brown, 13-jointed. *Thorax,* a reddish tinge on the shoulder of the collar; other parts black, rather densely pubescent. Three longitudinal lines somewhat obscured by the pubescence; two short lines extend half way from the collare to the scutellum and there is a short faint line over the base of the wings; scutellum rough, hairy; fovæ medium size; smooth spot on the pleura polished, shining, but not perfectly smooth. *Legs* brown, tips of the tarsi black. *Abdomen*

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seems probable the June flies oviposit in the galls from which they were produced.—Jan. 28, 1865.

black shining, second segment longest, separated from the third by a connate suture, third with microscopic punctation. Sheath of the ovipositor not turned up nearly so much as in *C. q. similis*, to which species it is closely related. *Wings* hyaline, sub-costal, first and second transverse veins pale brown, others colorless: lower part of the cubitus obsolete; areolet present; radial area open. Length .12.

Nine specimens.

I have a single male gall fly reared from the same galls, but it differs so much from the female that I am inclined to think it belongs to a different species. The thorax is quite smooth and shining, with a few short, scattering hairs, and only two longitudinal lines that closely converge at the scutellum. The venation of the wings is like that of the female described above, and is unquestionably that of a true gall-fly. The antennæ light dusky brown, 15-jointed; legs dark shining brown, nearly black, paler at the joints.

Though the galls are very much alike, the venation of the wings, the pleuræ, and several other points of difference mark it as a distinct species from *C. q. similis*. Dr. Fitch has figured the gall of his *C. q. tuber* which he found "quite common particularly upon the soft and tender limbs of young (white oak) trees" (*N. Y. Rep.*, Vol. 2d, No. 309). He describes (l. c. No. 310) the galls of *C. q. arbos* as "swellings similar to that above described, growing on the tips of the limbs of aged and large white oak trees."

My galls, which are probably identical with his *C. q. tuber*, were gathered from low, shrubby white oak bushes, though I have often seen precisely similar ones on large trees. Dr. Fitch's descriptions of the flies from *C. q. tuber* or *C. q. arbos* will apply, so far as they go, to either the gall flies, or to the guest flies as the inquilinæ are termed by Mr. Walsh. For the reasons that follow, I am led to think that the species he described under the above names are both inquilinious species.

1st. My galls were gathered about the 20th of June, and were then green and soft like the wood of the young shoots on which they grew. The insects were then in the pupa state, and the imago came out early in July. The gall from which Dr. Fitch's *C. q. arbos* was reared was found in March, and were of the preceding year's growth, as were also those of *C. q. tuber*, if we may judge from his description of the color

of the gall, which will only apply to the galls long after the true gall-flies have left them.

2nd. My galls gathered from young white oaks, and which answer perfectly to his figure and description of *C. q. tuber*, produced females with 13-jointed antennæ, while his have but 12 antennal joints.

3rd. I have gathered several hundreds of these galls in the autumn, winter and early spring within the last two or three years, but have never reared from them one true gall-fly, though they have produced large numbers of male and female guest-flies—the male answering perfectly to Dr. Fitch's description of *C. q. arbos*. The female he had not seen.

4th. The galls I collected in June have not yet produced any guest-flies, but cutting open several to-day I found in one a large living larva—the others were empty or contained dead gall-flies that had not been able to eat their way out of the dried gall.

From the above facts I am forced to believe that the galls *C. q. tuber* and *arbos* Fitch are both produced by the same fly, and that it is the same species that I have described above and for which I retain Dr. Fitch's name, *C. q. tuber*. Dr. Fitch has, no doubt, described two distinct flies, for Mr. Walsh, who has devoted much attention to the guest-flies of the oak galls, finds that not only do some species live in several different species of galls, but that the same kind of gall may produce more than one species of guest-fly. (*Proc. Ent. Soc. Philad.* Vol. 2d, p. 465.)

Mr. Walsh, in the article referred to, mentions other of Dr. Fitch's species which he is satisfied are inquilinæ, and not the producers of the galls from which they were reared. (See pp. 464–5, 484 and 494.) His remark that " *C. q. tuber* Fitch is in all probability a guest-fly," escaped my notice till this moment.

QUERCUS MONTANA. *Hard, round galls, .25 of an inch in diameter with a finely papillose surface and a solid radiated cellular structure; growing sometimes on the upper, but as often on the under side of the leaf; attached to the larger veins by a very short pedicel.*

These galls are rarely met with, and I have seldom found more than one on a leaf. In a single instance there were three on the same leaf, two on the under side and one on the upper. My specimens were found in October and contained perfect insects. Through the gall of several,

gathered October 20th, the insect had eaten a passage but they still remain in the galls.* Each contains a single, subapterous, female gall-fly, closely related to *C. q. forticornis* Walsh, and *C. q. pezomachoides* Osten Sacken. Dr. Fitch's figure and description of the gall of *C. q. pisum*, (*N. Y. Rep.* Vol. 2, No. 319,) answers well for this gall, but his were from a different species of oak, and this gall-fly is very distinct from that he describes. Baron Osten Sacken informs me that these subapterous females have winged males and belong to the genus Andricus.

I let this species stand with the related species named above and call it

C. q. hirta n. sp.

Head black, vertex slightly rugose, densely hairy as is also the entire dorsal portion of the thorax; face pubescent, hairs converging towards the mouth: palpi shining brown, tips black. *Antennæ* long, slender, black, 14-jointed. *Thorax* black, very small, densely covered with a coarse, yellowish-white pubescence. No striæ visible on the mesothorax. They are concealed by the pubescence if they exist. *Feet* a dull brownish black, but in a strong light appear of a very dark reddish brown, posterior pair lightest and all somewhat paler at the joints. *The wings* are mere yellowish white scales. *Abdomen* large, black and shining, a short, close pubescence on each side of the 2nd segment and this and the remaining segments, except the first, bounded across the back and sides on the posterior edge by a belt of long, silvery white hairs. These belts are divided on the dorsal ridge by a shining glabrous line like the anterior portion of the segment. These belts are plainly visible without the aid of a magnifier. Length .14.

Six ♀ specimens.

New species of galls, the flies of which are, as yet, unknown to me.

QUERCUS CHINQUAPIN. *Gall a cone-like body, developed from the axillary leaf-buds, and covered when green and often when dry with a dense, rose-like cluster of imperfectly developed leaves. The cell containing the larva smooth, shining, oval, about one-eighth of an inch long, half immersed in the apex of the cone.*—C. Q. FRONDOSA n. sp. Gall fly unknown.

These singular and very pretty galls are developed after the summer growth of the tree is completed, and the axillary buds are formed. The

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* November 29. A single fly was found in the box yesterday. It is quite active, and does not differ from those cut from the galls, showing those to have been mature.

sting of the insect causes the buds that would otherwise remain undeveloped till the following year, to develop in the autumn in the abnormal manner described above.

The rudimentary leaves are green, ligulate, and the more perfectly developed galls resemble, more than anything else I can think of, the flowers of the common Artemesia of the flower garden. They are not common, but I have several times met with them, and the clump of oak bushes from which my specimens were gathered was covered with them. The larvæ are now fully grown. On the same bushes I found a gall like *C. q. globulus* Fitch,—and several dry, brown galls on the petioles of the leaves, apparently those of *C. q. petiolicola.*

Q. RUBRA. *Clusters of seed-like bodies, often thirty or forty together growing on the midvein on the under side of the leaves of Q. rubra. The larger cells are about the size of a grain of wheat. They are smooth, greenish-white, the apex enlarged, and would remind a botanist of the sessile stigma of some flowers.*—C. Q. DECIDUA, n. sp. Gall fly unknown.

My specimens were collected about the first of October, and were then fully grown. Some had fallen to the ground, but on cutting open a large number I could not detect any larvæ. The leaf stems and twigs were placed in water to keep them green, but the galls soon dried and many fell off. A few fell into the water, and these not only kept green, but on opening them a few days since, half-grown larvæ were found. From this I infer that the growth of this species is dependent upon the galls being covered in the earth.

Gen. DIASTROPHUS.

DIASTROPHUS POTENTILLÆ, n. sp. Galls on Potentilla Canadensis. They are from .3 to .5 of an inch in diameter, and rather longer than thick, growing in the axils of the leaves; of a soft spongy consistence when dry, and each contains a single cell in shape and size like the nucleus of *C. q. globulus*, though not, like that, free from the substance in which it is enclosed. They are rather rare here (Conn.), but I saw large numbers of them in the northern part of Berkshire Co., Mass., last summer. The fly came out May 20th from galls of the previous year's growth. It is much like *D. nebulosus* O. S., but Baron Osten Sacken has compared it with this species, and pronounces it distinct.

Male.—Head black; vertex nearly smooth, the face black, finely aciculate, a ridge or carina from the vertex to the mouth, organs of the mouth with faintest possible tinge of reddish-brown. *Antennæ:* 1st, 2nd and 3rd joints black, the remaining ones dark cinnamon. 3rd joint not deeply incised, 14-jointed. *Thorax* black; collare hairy: mesothorax shining; two deep lines from collare converging towards the scutellum; space enclosed nearly smooth and hairless, with very faint longitudinal grooves. *Scutellum* sculptured, the basal pits large and deep. Lateral view of the scutellum shows as a cone, the axis of which is at an angle of 45 deg. from the axis of the body. *Legs* dark brown or black, coxæ black; femur and tibia yellowish brown, on the upper side darker; tips of tarsi black or nearly so; pleura very finely aciculate. *Abdomen* briefly petiolate, shining black, 2nd and 3rd segments connate jointed. *Wings* pale dusky; veins heavy, none of them reaching the margin; vein forming the base of radial area with heavy brown blotch. 1st transverse reddish-brown; areolet small distinct; radial area open. Cubitus disappearing before reaching the first transverse. Length (dry specimen) .11.

Female.—Antennæ 13-jointed, legs a shade darker than the male, otherwise as the male, though as usual larger, .13 long. The ocelli form nearly a straight line on the head. Abdomen in male and female perfectly smooth and shining.

In Mr. Cresson's Catalogue of described N. Am. Hymenoptera, ~~Di-plosis~~ *potentillæ*, Harris, occurs, taken from Dr. Harris' Catalogue of Ins. Mass. 2nd ed. I have not seen Dr. Harris' catalogue. Should my insect prove identical with his, I shall have only removed it to Diastrophus, the genus to which, without doubt, it properly belongs.

The following remarks and description were communicated to me by Baron R. Osten Sacken, for publication in this paper:

"In my paper entitled '*Additions and Corrections*,' etc., (*Proc. Entom. Soc.* 1862) I described a gall under the name of *C. q. strobilana* (l. c. p. 254), the producer of which was at that time unknown to me. Many months afterwards, I obtained the fly, by cutting the dry galls open. It belongs to the genus *Cynips* in the restricted sense (agamous according to Hartig), and I let its description follow:

Cynips quercus strobilana O. Sacken.

♀. Antennæ 14-jointed; body dark brown, with a close, appressed pubescence on the thorax and along the hind margins of the abdominal segments; feet brown; anterior knees and tarsi reddish; wings hyaline; length from 0.17—0.22.

Head black, finely punctured and pubescent; palpi reddish; antennæ rather short for the size of the insect, 14-jointed; third joint about as long as the two first, taken together; fourth, fifth and sixth gradually decreasing in length, the seven penultimate joints being nearly as long as broad; the last segment is somewhat longer than the preceding, although not equal in length to the two penultimate joints taken together; it shows no indication of a sub-division. *Thorax* densely clothed above with a yellowish, appressed pubescence, which

does not prevent, however, from distinguishing the sculpture; the latter consists of a moderately dense punctation and several rather shallow grooves, two of which, running from the collare backwards, end about the middle of the thorax by a slight, smooth and flat expansion. Pleuræ black, punctured, except a smooth, shining spot in the middle; their lower part is pubescent. *Scutellum* punctured above, rugose behind and finely pubescent; the pits at its base are of moderate size. *Abdomen* pitch-black, in some specimens slightly reddish below and along the hind margin of the segments; its whole surface, except the base of the segments and a narrow, smooth line along the back, is clothed with a whitish, appressed pubescence; under this pubescence a moderately dense punctation is perceptible; the second (largest) segment of the abdomen hardly reaches its middle. The feet are dark brown, pubescent; the base of the femora, the knees and the tarsi of the foremost pair are reddish; in some specimens a reddish tinge appears at the base of the femora and on the knees of the two posterior pairs. *Wings* hyaline; the second transverse vein forms a knee which bears a distinct stump of a vein in the middle.

Seven ♀ specimens."

WATERBURY, CONN., Dec. 1864.

CONTRIBUTIONS

TO THE

NATURAL HISTORY OF THE CYNIPIDÆ OF THE UNITED STATES

AND THEIR GALLS.

ARTICLE 3RD.

BY BARON R. OSTEN SACKEN.

[From the Proceedings of the Entomological Society of Philada., April, 1863.]

Contributions to the Natural History of the CYNIPIDÆ of the United States and of their galls. Article 3rd.

BY BARON R. OSTEN SACKEN.

Since my first articles on this subject (*on the Cynipidæ of the oak*, in Proc. Ent. Soc. Phil., Oct. 18 1, and *Additions*, etc., ibid. Sept. 1862), I have continued to work out the collections of galls and their inmates I had on hand; a large supply of materials I owe to the liberality of Mr. Norton. Thus I found myself able, in addition to the *Cynipidæ* of the oak, described in the above quoted papers, to prepare one on those of *the blackberry* and *the rose*, which I submit herewith to the friends of entomology.

The present publication does not exhaust the materials contained in my collection and I hope, in one or two more articles, to bring them also before the entomological public. As all these papers, although disconnected, serve to complete each other, thus gradually accumulating a store of materials for the future monographer, I have preferred to publish them henceforth under a general title.

NEW YORK, March 6, 1863.

CYNIPS-GALLS ON THE BLACKBERRY—(*Rubus* sp.)

The two cynipideous galls heretofore found on the blackberry bushes of this country are the produce of two species of the genus *Diastrophus* Hartig. This deserves to be noticed, as the first and only insect of this genus, described by Hartig, was also reared from a gall on the blackberry. Two more species have been described since by Mr. Giraud (Verh. Zool. Bot. Gesellsch. Wien, 1859, p. 368), the one reared from a gall on *Centaurea scabiosa*, the other captured in the net.

The genus *Diastrophus*, as all the other of Hartig's genera, has not been defined anywhere. From Mr. Hartig's analytical sketch (Germ. Z. II, p. 186, and from the addition to it, given l. c. IV, p. 410), we merely gather that *Diastrophus* has 15 (♂) and 14 (♀) jointed antennae, five-articulate maxillary and three-articulate labial palpi. The characters taken from the number of joints of the palpi, are, in my

opinion, of little practical value, as anybody can satisfy himself by trying to count them. As for the number of joints of the antennæ, it seems to vary. One of the species described below (*D. nebulosus*) has 14 (♂) and 13 (♀) joints; Giraud's *D. scabiosæ* has the same number; of his *D. areolatus* he possessed only the ♀ and it likewise has 13 joints. The other N. American species, however, which I describe below (*D. cuscutaeformis*) has, like Hartig's *D. rubi* 15 (♂) and 14 (♀) joints.* What Hartig says about the antennae of the ♂ (l. c. p. 410, at bottom), "that the last joint is subdivided in two joints of nearly equal length, thus making 15 joints", seems to indicate a structure similar to that of *D. cuscutaefomis* ♂, where the 15th joint appears to be a mere subdivision of the 14th.

One of the most curious circumstances connected with the history of two North American blackberry galls, observed by me is, that besides the *Diastrophus*, apparently the genuine originator of the gall, they produce another gall-fly, probably parasitical, belonging to the genus *Aulax* Hartig, and showing the most striking resemblance in size, coloring, and sculpture, to the *Diastrophus*, their companion. The one is the very counterpart of the other, hardly showing any differences, except the strictly generic characters! This seems to be again one of those curious instances, so frequent in entomology, of the resemblance between the parasites and their hosts! By rearing a considerable number of galls of *D. nebulosus*, I obtained this species as well as its parasite almost in equal numbers. By cutting some of the galls open, I ascertained that a single specimen of the gall frequently contained *both species*, thus setting aside a possible doubt whether these insects are not produced by two different, although closely similar galls.

From the gall of *D. custutaeformis* I also obtained an *Aulax* (comp. below).

The genus *Aulax* Hartig (*Aylax* in Germ. Z. II and III, *Aulax* in vol. *IV*, p. 412) is not much better defined than *Diastrophus*, and I owe the determination of both to Dr. Rheinhard, in Bautzes, Saxony.

Aulax, according to Hartig, has the antennæ 15 or 16 jointed (♂), 14 or 15 jointed (♀). The three species described by Giraud have all 14 (♂) and 13 (♀) joints.

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* I have to add, however, that I can count only 13 joints in the ♀ specimens of *D. rubi*, kindly sent me by Dr. Rheinhard.

My *A. sylvestris* has 14 (♂) and 12 (♀) joints. Another North American species, parasitical in the gall of *Rhodites radicum* O. S. is, in this respect, like the preceding.

The striking difference in the structure of the abdomen of the ♂ and the ♀ is, as Mr. Rheinhard informs me, a peculiarity of this genus. As to the position of *Aulax* in the system, that assigned to it by Hartig is somewhat doubtful, as, according to his statement, some of its species are true gall-producers (*Psenides*), others parasites (*Inquilinae*). The further observations of Giraud have not dispelled these doubts. Of the European 16 species at present described, *seven* are said to produce galls on *Salvia*, *Scorzonera*, *Papaver rhoeas*, *Hieracium* and *Glechoma*; *three* have been reared from galls of other species, (two from *Rhodites*-galls on the rose, one from an oak-gall of *Andricus*).

The N. American *Aulax* known to me at present, are all parasites. *A. sylvestris*, described below, lives in the gall of *Diastrophus*; *Aulax semipicea* Harris is obtained from the root-gall of the rose (*Rhodites radicum* O. S.), and was mistaken by Dr. Harris for the originator of this gall. A third species, *A. futilis*, which I described in my paper on the Cynipidæ of the oak (Proc. Ent. Soc. Phil. 1, p. 64) is somewhat doubtful, as I was not well acquainted with the characters of the genus *Aulax* at that time, and have accidentally broken since the only specimen, which I reared from the gall of *Cynips q. futilis* O. S. I moreover possess three other species, all reared from rose-galls, and of one of which (*A. infuscatus* O. S.) I give a short description below.

This inconstancy in the habits of the species of the same genus is rather anomalous, and requires further observation. I would remind here of a very common reniform gall occurring on *Vaccinium* in this country, and from which, although collected quite abundantly, I never reared anything but two *Chalcidii*: a *Decatoma* and a *Pteromaloïd* insect. Would this be considered as a sufficient proof that either of these insects is the originator of the gall? The neuration of the wings of the species of *Aulax*, especially the form of the radial area, undoubtedly establishes their relationship to the parasitical Cynipidæ (*Inquilinae*).

Hartig says (l. c. III, p. 334) that the radial area in *Aulax* is closed in some species, open in others. Judging by the structure of this area in *A. sylvestris* and *A. semipicea*, I am inclined to believe that this character, at least in this genus, is a very indefinite one, as the closing

of the radial area is not so much due to a vein, as to a thickening of the margin of the wing, which appears like a prolongation of the subcostal vein. This thickening is more or less apparent in different species, and hence, doubts may often arise as to the radial area being open or closed. (Hartig himself, pag. cit., calls it, in some species, *half-closed.*)

The two N. American *Diastrophus*-galls and their insects may be described as follows.

Rubus villosus (?). *Blackberry. Elongated, abrupt, pithy swelling on the twigs, from an inch to three inches in length.* Diastrophus nebulosus n. sp.

This deformation, chiefly due to a hypertrophy of the pith, in consequence of the sting of the insect, is very common in the environs of Washington. Its color is generally dark red or reddish brown; its shape oblong; its surface generally uneven with irregular tubercles, or with deep longitudinal furrows, dividing the whole gall in four or five parallel ridges. The full-grown specimens are usually 2 or 3 inches long, and from ¾ to an inch in diameter. A transverse section of the gall shows a large number of oblong cells, about 0.13 long, arranged for the most part near the middle of the gall; their intervals are filled with soft pithy matter and harder woody fibres. From galls collected in the fall, the insects usually come out during the winter and in the spring.

Besides the *Diastrophus* and the *Aulax*, I have reared from these galls parasites belonging to the genera: *Callimome* (two species), *Ormyrus* and *Eurytoma*.

Diastrophus nebulosus n. sp.—Pitch-black, smooth and glossy above, antennæ and feet red; wings hyaline *areolet distinct*, second transverse vein and tip of the subcostal slightly clouded; length, ♂, 0.08—0.1; ♀, 0.1—0.11.

♂ antennæ 14 jointed; third joint slightly excised below.
♀ " 13 " third joint entire.

Head pitch-black, mandibles more or less reddish, tip black; face also sometimes tinged with brownish or reddish, especially round the mouth, the face is sculptured with fine scratches, (aciculated) convergent towards the mouth; its middle shows an elongated, smooth swelling; above antennæ, the head is smooth and shining; antennæ reddish sometimes darker at tip, (♂) 14, (♀) 13-jointed; the 3d joint of the ♂ is the largest, excised beneath; last joint longer than the preceding, but shorter than the two preceding taken together, pointed, almost conical; last joint of the ♀ as long as the two preceding together, subcylindrical, pointed, showing slight indications of a subdivision into three joints;

thorax pitch black, collare and humeri aciculated, reddish in some specimens; the smooth, shining space on the pleuræ is aciculated below, near the coxæ; the mesothorax is smooth and shining above; interval between the parapsidal grooves smooth; scutellum gibbose, black, densely sculptured, with two pits at base; abdomen pitch-brown, slightly tinged with red at base, second segment* equal to half the length of the abdomen; the third somewhat shorter, the following very short; feet, including coxæ, reddish, onychia blackish; wings hyaline, radial vein not reaching the anterior margin; both transverse veins and the two latter segments of the subcostal more or less infuscated; areolet distinct, of moderate size, slightly petiolate that is, separated by a short stout vein from the adjoining corner of the radial area; two almost obsolete narrow, diverging pale brownish streaks in the apical area; they are frequently altogether indistinct.

Numerous ♂ and ♀ specimens. The coloring is more or less brownish or reddish, according to the degree of maturity of the specimens.

Aulax sylvestris n. sp.—Pitch-black, antennæ reddish, feet yellowish-red; space between the parapsidal furrows somewhat punctate anteriorly; areolet distinct: wings hyaline; length, ♂, 0.09—0.1; ♀, 0.1—0.12.

♂; antennæ 14-jointed; second and third segments of the abdomen not differing much in length; the others short.

♀; antennæ 12-jointed the second segment of the abdomen occupies almost the whole of its surface.

Head black, face aciculate, the scratches converging towards the mouth, front and vertex glossy and shining. Thorax black; prothorax opaque, finely pubescent, sculpture indistinct; dorsum of the mesothorax shining, although a strong magnifying power shows that it is minutely punctured; pleuræ with a large, smooth and glossy square space, the lower side of which is somewhat aciculated; scutellum gibbose, deeply rugose-punctate, with the two usual basal pits; abdomen pitch brown, verging in chestnut brown or yellowish brown below; feet reddish yellow; wings hyaline; veins yellowish brown, not clouded, radial area open (that is, not limited by a vein along the costa).

Many ♂ and ♀ specimens.

As stated above, there is the most striking resemblance in sculpture and coloring between this species and the preceding. In order to complete their descriptions, I will add here a detailed comparison between them.

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* In order to avoid a possible misunderstanding, I remind here, that in this paper, as in my preceding papers on *Cynipidæ* I call *second* segment that which is *apparently* the first, thus following Dr. Rheinhard's terminology. (See my paper: On the *Cynipidæ*, etc., Proceed. Entom Soc Phil. Vol. I, p. 48 in the note.)

Diastrophus nebulosus.	Aulax sylvestris.
♀ antennæ, 13 jointed, last joint as long as the two preceding taken together, etc.	♀ antennæ, 12-jointed, last joint longer than the two preceding taken together, subcylindrical, showing a subdivision in three joints.
♂ antennæ 14-jointed; 1st joint longer, last joint shorter than in *A. sylvestris*.	♂ antennæ, 14-jointed; first joint shorter, last joint longer than in *D. nebulosus*.
Prothorax (collare) and humeri aciculated.	Prothorax and humeri indistinctly punctured and finely downy.
Thorax smooth and very shining above, without any vestige of a sculpture, except the usual furrows.	Dorsum of the thorax appearing minutely punctured under a strong magnifying power, and therefore somewhat less shining than in *D. nebulosus*.
Interval between the anterior ends of the parapsidal grooves (near the prothorax) smooth; the two short, intermediate grooves usually apparent there, are hardly perceptible.	Interval between the anterior ends of the parapsidal grooves with some distinct punctures; the two short, intermediate grooves are apparent.
♂ abdomen oval, more or less attenuated and pointed (not truncate) behind; it is compressed from above that is, its vertical diameter is longer than, or at least equal to, its transverse diameter.	♂ abdomen bell or funnel-shaped, truncate behind; it is compressed from the sides, that is, its transverse diameter, at the broadest place is shorter than its vertical diameter.
♀ abdomen in structure, like that of the ♂ (with the usual sexual differences); that is, the second and third segments of the abdomen do not differ considerably in length.	♀ abdomen very different in structure from that of the male, as the second segment occupies almost its whole surface, the following ones being either concealed under it or protruding but little beyond it; the abdomen is strongly compressed from the sides, that is, its vertical diameter is much longer than the transverse one; seen from above, the abdomen appears somewhat bell-shaped in outline, being oval and truncated at top.
Sheath of the ovipositor concealed.	Sheath of the ovipositor directed upwards and protruding distinctly.
Wings. Subcostal, first and second transverse veins much stouter than the others and clouded with brown.	Subcostal, etc., not, or very slightly, stouter than the radial vein, not clouded with brown.
Second transverse vein slightly arched and shorter than in *A. sylvestris*.	Second transverse vein straight and longer than in *D. nebulosus*.

The consequence of this last difference is that the radial area of *Aulax* is broader, resembling in this respect those of the other *Inquilinae*, whereas the narrower, although short, area of *Diastrophus*, with the areolet nearer its basis, is more like those of the true Cynipidæ (*Psenides*). Other differences between the two species are, that *A. sylvestris* has the areolet slightly larger, that its feet are somewhat paler, etc.

Rubus sp. *Blackberry. A number of small, round, hollow bodies, forming a cluster round a branch.* Diastrophus cuscutæformis n. sp.

I possess two specimens of this gall, collected near Bladensburgh, Md., and kindly communicated to me by Mr. Hitz.

The globular, seedlike bodies, each having about 0.1 in diameter and producing a single insect, are (in one of my galls) from 60 to 70 in number, and occupy a space of about an inch and a half on the branch. They are pressed closely together and offer some resemblance to the seeds of *Cuscuta*, when found in winter attached to a stem. Many of the round bodies emit more or less strong spines, which impair in a measure the regularity of their form. The consistency of their shell is woody; their color brownish, like that of the branch.

I was unable to ascertain on what species of *Rubus* this gall occurs.

Besides the *Diastrophus*, originating this gall, I have obtained from it an *Ormyrus* and an *Aulax*, which, as far as I can judge from a single specimen, is my *A. sylvestris*, also reared from the other blackberry-gall.

Diastrophus cuscutaeformis n. sp. Pitch brown or black; antennæ and feet red; *areolet wanting;* wings hyaline, a small brown cloud near the anterior margin, on the angle formed by the second transverse vein and the tip of the subcostal; ♂ 15 (?), ♀ 14 jointed antennæ.

This species is like *D. nebulosus* in sculpture and coloring, with the following differences: 1. The ♀ antennæ are 14 (and not 13-jointed); the last joint is *shorter* than the two preceding taken together, subconical, pointed; the ♀ antennæ (at least in the only specimen of that sex which is in my possession) have the 14th joint elongated and subdivided by a somewhat indistinct suture in two unequal halves, the posterior one being the shortest and thus forming a minute 15th joint.

2. The color of the antennæ is somewhat more brownish. 3. The face is aciculated all over its surface, without any smooth spot in the middle. 4. The scutullum is drawn out into a point, almost subconical. 5. The wings have no areolet (two specimens have an irregularly formed areolet on the left wing only); this cell, however, cannot even be considered as a true areolet, as, instead of being formed by a bifurcation of the second transverse vein, it occupies the lower corner of the radial area. 6. The brown cloud near the tip of the subcostal vein is larger and more distinct; this portion of that vein is very stout, dark brown, and is distinctly attenuated before reaching the margin, whereas in *D. nebulosus* it has the appearance of touching the margin, and is paler brown and less distinctly attenuated. 7. The pale brown clouds, in the form of streaks, towards the tip of the wing, which exist in *D. nebulosus*, are wanting here.

One ♂ and eight ♀ specimens. The ♂ is easily distinguished by the third antennal joint, excised below. The coloring of this species, like that of the preceding, is frequently more or less brownish or reddish, especially on the face, the collare and the humeri, according to the maturity of the specimens.

Cynips-galls on the Rose.

I. The Galls.

I am acquainted with eight cynipideous galls on the different kinds of roses of this country. My account of them is, perhaps, not so complete as I would desire it, as most of these galls have not been observed by myself, but were communicated to me by others.

1. *An agglomeration of hard cells round a branch, the whole covered with long and dense greenish filaments and forming a moss-like mass of an inch and a half or more in diameter.* This, or a similar gall (see Reaumur, vol. III, Tab. 47) is well known in Europe under the name of the *bedeguar*, (from the Hebrew *bedeguach*, said to mean *rose-apple*), and was formerly used medicinally. I cannot discover any difference between the gall-fly obtained in this country and some European specimens of *R. rosae*, communicated to me by Mr. Rheinhardt. One specimen of the gall from New York, was communicated to me by Mr. Glover; another, with numerous female *Rhodites* reared from it, by Mr. Norton. Mossy galls of simillar appearance, but much smaller,

occur frequently on rose leaves. I do not know whether they are the produce of the same insect. Besides the ordinary parasites, a beautiful *Eupelmus* with rudimental wings and two elevated ridges on the mesothorax, has been reared from this gall.

2. *Hard, woody, irregular swelling of the branches, generally about two inches long and about half an inch or a little more in diameter.* This is the gall of *Rhodites dichlocerus* Harris (Harris, Insects, etc., p. 549, Tab. VIII, p. 8, of the 3d edition). Specimens from New York and Connecticut were communicated to me by Mr. Akhurst and Mr. E. Norton. The ♂ and ♀ insect are described below under the above name. *Aulax*, *Callimome*, *Ormyrus* and *Eurytoma* were reared from this gall.

Several ♀ specimens of *Rhodites* apparently identical with *R. dichlocerus* were labelled in Mr. Norton's collection as having been reared from the elongated, densely prickly rose-gall (comp. below, No. 8). If this is not a mistake, it would lead to one of the two conclusions : either the insects obtained from the two galls offer some nice distinctions which escaped my scrutiny, or the prickly gall No. 8 is a mere variety of the other.

3. *Oblong or rounded swellings of the small branches.* They vary in appearance, as there is sometimes one more or less oblong swelling, containing two or three cells, and about one third of an inch long, sometimes a series of three or four such swellings, which, although continuous, do not coalesce entirely, each preserving its rounded shape. In this respect this gall is very different from the preceding, which, in the majority of specimens, is a more continuous swelling, tapering at both ends.

When cut open, the galls appear more hollow than those of *R. dichlocerus*, and this for the very plain reason that, although being smaller, they produce insects, and consequently contain hollows, of the same size. There also seems to exist a constant difference in the color of both galls; the specimens of the gall of *R. dichlocerus* in my possession have a more or less dark, purplish-red skin; those of the other gall are either green, when found on young, green twigs, or they have the color of a dead branch. I found this gall near Washington, and reared from it (besides the *R. verna* n. sp. described below), *Eurytoma*. *Ormyrus*, *Eupelmus*, *Tetrastichus* and *Pteromalus*. A small moth had also taken refuge within one of the probably empty galls.

4. *Rounded, warty, sometimes very large gall, smooth on the outside, occurring on the roots of roses and containing numerous cells, with an intervening pithy matter.* This is the gall described by Dr. Harris (l. c. p. 549), as the gall of *Cynips semipicea* Harris. But Dr. Harris's description of this insect does not refer to the true originator of the gall, *Rhodites radicum* n. sp. (described below). Dr. Harris says: they resemble closely the *dark varieties* of *C. dichlocerus* in color and in the little furrows of the thorax, *but their legs are rather paler and they do not measure more than one-tenth of an inch in length.*" *R. radicum* is much larger than one-tenth, and its legs instead of being paler, are on the contrary conspicuous among those of the other *Rhodites* by the intensity of their brownish-red color. Dr. Harris's description probably refers to a parasite (perhaps an *Aulax*).

Specimens of this gall have been communicated to me by Mr. Norton and Mr. Akhurst. *Eurytoma*, *Callimome*, *Ormyrus* and an *Eupelmus*, with rudimental wings, have also been reared from it.

5. *Rounded, smooth, abrupt swellings of the branches.* The outside of this gall (form, color and skin), is not like the preceding. Some of them remind by their appearance the galls of *Diastrophus nebulosus* on the blackberry. They are easily distinguished from *R. dichlocerus* (No. 2), as they rise abruptly from the branch, whereas the other gall is gradually tapering at both ends. The substance of this gall is rather soft, corky, with numerous cells. The form is more or less oblong, sometimes almost round; my specimens measure from three-fourths of an inch to an inch and a quarter in length; the largest is a little more than three-fourths of an inch broad.

Mr. Norton, to whom I owe the communication of this gall, reared from it a very large number of specimens of an *Aulax*. Until further proof I cannot, however, consider this insect as the originator of the gall. I am also doubtful, whether several specimens of *Rhodites* (described below as *R. ignota* n. sp.) in Mr. Norton's collection, marked as being obtained from "smooth rose-galls," belong here, as precisely similar specimens were reared from another gall (comp. gall. No. 7).

Aulax pirata n. sp.—Black, with reddish-yellow feet and antennæ; base of coxæ black; thorax pubescent; wings hyaline; length ♂ 0.08, ♀ 0.1.

Head black, mandibles somewhat reddish; face finely pubescent, a longitudinal protuberance between the mouth and the antennæ; the interval between it and the eyes is finely aciculated, the scratches converging more or less to-

wards the mouth; antennæ reddish (somewhat brownish in some of the ♀); 14-jointed in the ♂, the third joint very strongly excised on the underside, with projections on both sides of the excision which give this joint an almost reniform or crescent-shaped appearance; last joint but a little longer than the preceding; ♀ antennæ 12-jointed, third joint without excision, last joint much longer than the preceding, although not quite as long as the two before last taken together; thorax black, finely pubescent, finely but densely sculptured, and therefore not very shining, although not opaque; parapsidal grooves not deep, and distinctly apparent only from a side view; intermediate grooves indistinct, shallow, convergent; pleuræ with a large, polished space, which appears aciculated only under a strong magnifying power; scutellum protuberant, deeply rugose, opaque, with two small pits at the bottom; abdomen black, polished; in the ♂ elliptical, base finely pubescent above, the third segment longer than the second; the following ones contracted; the tip finely punctured and pubescent; in the ♀ somewhat rhomböidal on a side-view, flattened from the sides; the second segment occupies nearly the whole of its surface; the following ones contracted: the last one finely pubescent; sheath of the ovipositor exserted above the abdomen, pointing upwards; (the structure of the ♀ abdomen is exactly the same as that of *A. sylvestris*, n. sp. described on page 37); wings hyaline, veins pale; second transverse vein somewhat arched; margin of the wing inside of the radial area thickened, so as to make it appear closed; areolet of moderate size.

A large number of ♂ and ♀ specimens.

6. *Round galls, about* 0.3 *or* 0.4 *in diameter, covered with prickles about as long as the diameter of the gall.* Sometimes three or four of these galls are in a cluster. This is the gall of *Rhodites* (Cynips) *bicolor* Harris (l. c. p. 548). Gall and fly were communicated to me by Mr. Norton; the fly is described below. Besides other parasites, numerous specimens of an *Aulax* were reared from it by Messrs. Norton and Akhurst. This *Aulax* is hardly different from *A. pirata*, described above.

7. *Round galls of the size of a pea, covered with a white efflorescence, on the leaves of Rosa carolina.* Sometimes two or three of these galls coalesce, thus forming an elongated mass of more irregular shape. The leaf is often almost wholly obliterated, the galls growing near the central rib. The substance (at least that of the dry galls which I have for examination), is hard and woody. Each gall contains several cells. They were communicated to me by Dr. Foreman, who found them in Maryland, but, except a *Callimome*, I obtained nothing from them.

Among the galls communicated to me by Mr. Norton, there is a

single specimen of one, which is not unlike the preceding, and may be the same gall; it consists of a mid-rib of a leaf, on which are four rounded galls, somewhat, although not entirely coalescent, each retaining its rounded form; the specimen is about 0.8 long, the diameter of each of the galls being 0.15 or 0.2. The surface is finely, irregularly netted, yellowish and not whitish-mealy like the other. From this gall were obtained two ♂ specimens, which apparently belong to the species described below as *R. ignota.* The latter species was labelled in Mr. Norton's collection as being reared from a "smooth rose-gall." (See above, No. 5).

8. *Elongated swelling of a twig, covered with numerous, dense prickles.* I owe to Mr. Glover a specimen of this gall, a section of which shows cells, evidently belonging to a cynipideous insect. The originator of the gall is unknown to me; but in Mr. Norton's collection several ♀ specimens of an insect apparently identical with *R. dichlocerus* were labelled as being reared from a similar gall.

II. Rhodites Hartig.

The genus *Rhodites*, in Europe as in N. America, seems to be exclusively confined to the rose. Five European species are known, all producing galls on this shrub. Six North-American species, which all share the same mode of living, are described below; one of these species (*R. rosæ* L.) is common to Europe and N. America.

Rhodites as a genus, is very easily distinguished by its general appearance, although it is no more satisfactorily defined than the other cynipideous genera. Hartig, for instance, counts 15 and 16 joints on the antennæ, whereas I never found more than 14 *in both sexes.* The last joint shows, it is true, a kind of suture in the middle, but this suture is no true division of a joint, as can be easily ascertained by comparing it to the other divisions; moreover, it occurs in both sexes and may even be indistinctly perceived in some of the other joints. The third joint is the longest, generally as long as, or a little longer than, the two following taken together. The underside of the last abdominal segment is drawn out here in a long point, which seems to be peculiar to the genus; in *Diastrophus* for instance, the tip of this segment is more or less truncated.

The sexes are frequently distinguished in this genus by the coloring of their abdomen and wings; the neuration as well as the sculpture of the thorax are generally the same in both sexes.

Analytical table for the determination of the species.

MALE SEX.

1. Whole abdomen black..2
   Basal third of the abdomen red; areolet small, often wanting..**R. dichlocerus** Harris.
2. A stump of a vein, or at least a pointed or angular projection inside of the radial area on the second transverse vein..3
   No such stump or projection, the second transverse vein, inside of the radial area, being smooth..5
3. A short, brown line or projection, like the stump of a vein, on the underside of the areolet, near the angle directed towards the tip of the wing; elongated brownish clouds, indefinite in outline, in the apical area..**R. bicolor** Harris.
   No such line or stump 4
4. A more or less distinct brown spot or cloud at the tip of the radial vein, near the margin of the wing; another on the transverse vein between the areolet and the margin; *space of the radial area between these two clouds hyaline;* no glossy, shining spots on the pleuræ..**R. ignota** n. sp.
   Radial area tinged more uniformly than in the preceding species; pleuræ with smooth spots, which are much more glossy than their surroundings........**R. rosæ** Linn.
5. Parapsidal grooves remarkably deep; areolet small, radial and apical areæ clouded..............................**R. radicum** n. sp.
   Parapsidal grooves very moderate, areolet of ordinary size; hardly any distinct clouds on the radial and apical areæ..**R. verna** n. sp.

FEMALE SEX.

1. Whole body pale chestnut......................................**R. dichlocerus** Harris.
   Body black..**R. radicum** n. sp.
   Head and thorax black, abdomen red..2
2. Whole abdomen red..3
   Three or four of the last segments black ....**R. rosæ** Linn.
3. No stump or projection on the second transverse vein, inside of the radial area; the latter and its surroundings clouded with pale brownish....................**R. verna** n. sp.
   A stump of a vein or a pointed or angular projection on the second transverse vein, inside of the radial area..4
4. Radial area and its environs clouded; a short brown line, like the stump of a vein on the underside of the areolet..**R. bicolor** Harris.
   Two small, but well-marked clouds occupy both sides of the radial area, its middle being hyaline.............**R. ignota** n. sp.

Description of the species.

Rhodites dichlocerus Harris.

Syn. *Cynips dichlocerus* Harris, Ins. of Mass. 3d edit. p. 549.

♂ 0.1 long, black, base of abdomen red.

♀ 0.14 long, brownish red, antennæ black, except the three basal joints.

♂ Head black, dark reddish behind, sometimes also with a reddish spot on the inside of the eye; mandibles (except tip) and labrum red; two basal joints of the antennæ often reddish-brown. Thorax black, subopaque, pubescent, punctate and rugose, parapsidal grooves well marked, intermediate grooves flat, with a shining bottom; often a reddish spot on the pleuræ, immediately over the anterior coxæ, sometimes one on the scutellum; abdomen black, yellowish-red at base; this red has more extent on its sides (where it sometimes reaches the third segment), than on its back; feet red; coxæ red with black base, sometimes black with reddish tip; tip of tarsi black; wings hyaline; the second transverse vein curved or angular; areolet either of moderate size, or very small, or altogether wanting, its sides coalescing into one stout vein (this is quite often the case with this species).

♀ Head brownish red, cheeks generally more brownish; antennæ: three basal joints, except the very tip of the third, red; the remainder black; thorax brownish red, sculpture as in the ♂; abdomen brownish red: pointed tip of the lower half of the last segment, brown; wings pale brownish; radial area and surroundings clouded with pale brown; areolet extant; second transverse vein angular.

Numerous ♂ and ♀ specimens; the latter more common. Mr. Harris does not notice the difference in color of the ♂ and the ♀; he only mentions a darker variety, which may be the ♂. Some of the ♂ specimens are much smaller than the others, and with much less red at the base of the abdomen.

The gall is described above (No. 2).

Rhodites radicum n. sp.

♂ 0.13 long; coxæ black.

♀ 0.15 long; coxæ dark reddish, their base black.

Head and antennæ black; two basal joints of the latter sometimes reddish-brown; mandibles reddish; thorax black, somewhat shining, densely, but very finely and uniformly sculptured, so as to give its surface a silky appearance; parapsidal grooves *broader and deeper than in the other species*, running down to the humeri; intermediate grooves short, but well marked; pubescence of the thorax above scattered and hardly apparent, except on a side-view; pleuræ with two smooth and shining oblong spaces; humeri very rugose, scutellum likewise; abdomen black, shining, sometimes brown; borders of segments sometimes paler; feet dark red, two hind pairs of femora infuscated, especially at base; tips of tarsi brown; wings: radial and apical areæ and a portion of the cubital clouded with brown; areolet rather small; its angle, directed towards the base of the wing, is for the most time pale, subobsolete; the portion of the cubital between the first transverse vein and the areolet is often subob-

solete or obsolete in this species; the second transverse vein is smooth, without projection inside of the radial area, although sometimes slightly angular.

The sexes in this species are more alike than in any other; they are, however, easily distinguished by the structure of the abdomen.

The specimens which I possess in considerable number, were communicated to me by Mr. E. Norton.

As already noticed above, Dr. Harris's *C. semipicea* cannot possibly refer to this species. (Compare about it the description of the gall, under No. 4.)

Rhodites rosæ Linn.

♂ Black.

♀ 0.13—0.15 long, abdomen red, black at tip.

♀ Head and antennæ black, mandibles reddish, thorax black, pubescent, smooth and but finely sculptured, parapsidal grooves not deep, and quite indistinct when viewed from above, stopping some distance before reaching the humeri, intermediate furrows well marked, shining at bottom, pleuræ with two oblong, shining spots, abdomen red, the four last segments black; feet red, coxæ and tip of tarsi black, wings pale brownish, with a brown cloud on the radial area and its surroundings; the second transverse vein, which is angular, has a small, but distinct projection within the radial area; areolet of moderate size.

The sculpture of the thorax is not dense enough to render it opaque and it retains some of its gloss; in this respect it resembles the *R. verna*. By all means, the black tip of the abdomen renders this species sufficiently distinct.

The male seems to be very rare, as among 200 specimens which passed through my hands, thanks to Messrs. Norton and Akhurst, there was only a single ♂. I was unfortunate enough to lose it in attempting to paste it on paper. The glimpse I had of it was sufficient to show that its abdomen was black, and its wings less tinged with brown. (The European *Rhodites rosæ* ♂ has also a black abdomen.)

The gall of this species has been described above (under No. 1); it is similar to the European gall, known as the *bedeguar* of the rose. I could not perceive any difference between my specimens of the European *R. rosæ* Linn. and the American insect.

Rhodites verna n. sp.

♂ 0.1—0.11 long, body black, feet red, coxæ black.

♀ 0.15 long, abdomen red; feet, including the coxæ, red; base of the latter black.

Head and antennæ black, mandibles reddish, thorax black, *finely, not densely sculptured, somewhat shining, pubescent, parapsidal grooves moderately deep;*

they touch the humeri; the intermediate grooves generally appear as smooth lines, unless viewed obliquely; scutellum rugose on the sides, more smooth in the middle, but, in general, *not so rough in appearance as in most other species;* abdomen (♂) black, (♀) red, *fringed with pale yellowish hairs on the hind borders of the segments;* tip of the point on the underside of the ♀ abdomen brown: basis of ♂ femora brownish; wings ♂ hyaline, ♀ somewhat tinged with brown and with a more or less distinct cloud on the radial area and its surroundings: in both sexes, the second tranverse vein has no projection within the radial area and is arcuate; the areolet is of a moderate size, larger in ♀.

Two ♂ and 16 ♀ specimens reared by me in Washington, from the galls. These have been described above (No. 3).

The fringe of pale yellow hairs on the border of the ♂ abdominal segments seems to be peculiar to this species, as it is quite distinct in all my specimens, whereas I do not notice it in the numerous specimens of other species, communicated to me by Mr. Norton.

R. verna resembles in coloring *R. bicolor* and *R. ignota;* but the latter is easily distinguished by the peculiar coloring of its wings; *R. bicolor* by its less pubescent, more roughly sculptured, and therefore more opaque thorax and scutellum, the structure of its second transverse vein, etc.

Rhodites bicolor Harris.

♂ 0.15 long, black; feet red, coxæ black.

♀ 0.15—0.16 long, abdomen red; feet and coxæ, except at the base, red.

This species is so much like the preceding, in both sexes, that it will be sufficient, for its recognition, to notice the differences.

Thorax less pubescent, somewhat more roughly sculptured and therefore more opaque; parapsidal furrows somewhat deeper; the intermediate furrows appear as *distinct ridges* when viewed obliquely; scutellum, likewise, more deeply rugose; the smooth, glossy spots existing on the pleuræ of some other species *are hardly apparent here*, these spots being sculptured more or less like the remainder of the pleuræ; the brownish cloud on the radial area of the ♀ is more intense; the ♂ wing is also somewhat clouded along the stout veins and has two indistinct clouds in the apical area; the second transverse vein has a light projection about its middle, in the radial area (in some specimens this projection is very small); the veins forming the *anterior* angle of the areolet, as well as the portion of the cubital vein, preceding the areolet, in this species are thin, often subobsolete; said portion of the cubital vein being often merely indicated by a brownish streak (without vein); *there is a short, pale brown line, as if a stump of a vein, close by the posterior angle of the areolet,* (that is the angle, which is nearer the tip of the wing), on its out and underside. This last mark, trifling as its seems to be, exists in precisely the same degree of distinctness, in the nine specimens which I have before me.

A single ♂ and 8 ♀ specimens, communicated by Mr. Norton and

reared by him from the gall (see above, No. 6). The male is considerably larger than that of *R. verna.*

Rhodites ignota n. sp.

♂ 0.12—0.13 long, black; feet red; coxæ and base of femora black.

♀ 0.14 long, abdomen red; feet, including coxæ, red.

Head and antennæ black, mandibles brownish red, thorax black, densely rugose, opaque; parapsidal furrows not very distinct, intermediate ones likewise; the latter, in some specimens, have the appearance of small ridges; no distinct, smooth, shining spots on the pleuræ, especially in the ♀; wings: second transverse vein angularly bent, with a projection in the middle, inside of the radial area; (in some specimens, especially the ♂, this projection is quite large, like the stump of a vein); radial area shorter than in the other species, the radial vein being slightly arched; the margin of the wing within this area is thickened, so as to appear like a vein, closing the area; a brown spot between the areolet and the anterior margin; another one at the tip of the radial vein, near the margin; (in the ♂ these spots have often very little extent, appearing only like brownish margins along the veins): *the space of the radial area between these spots is hyaline;* the tinge of the ♀ wing is somewhat yellowish, whereas that of the ♂ is more hyaline.

The thorax of this species is proportionally smaller than the thorax of *R. verna* or *bicolor*, and hence the body has a more slender appearance.

Four ♂ and two ♀ specimens were in Mr. Norton's collection, with labels indicating that they had been obtained from a "smooth rose gall". Is it the gall described above under No. 5? This seems doubtful, as two other males, apparently of the same species, were reared from quite a different gall, described under No. 7.

ERRATA.

Some corrections in my paper have become necessary in consequence of my having made a change in the latter part of my manuscript, and having forgotten to introduce a corresponding alteration in the preceding text. These corrections refer all to page 35 and are as follows:—

Line 1 and 2 from the top. Instead of Another North American species parasitical in the gall of *R. radicum,* read: My *Aulax pirata,* parasitical on rose-galls, is, etc.

Line 15 and 16. For *Aulax semipicea* Harris is obtained, read: *Cynips semipicea* Harris is probably an *Aulax,* obtained etc.

Line 17. Strike out the word *was.*

Line 23. For *three* read *two.*

Line 24. For *A. infuscatus* read *A. pirata.*

Line 2 from the bottom, for *A. semipicea* read *A. pirata.*

On page 39, line 8 from the bottom, after the word antennæ, add: Length, ♂ 0.08; ♀ about 0.1.

(Article 2d)

ADDITIONS AND CORRECTIONS

TO THE PAPER ENTITLED:

"ON THE CYNIPIDÆ OF THE NORTH AMERICAN OAKS AND THEIR GALLS."

BY BARON R. OSTEN SACKEN.

[From the Proceedings of the Entomological Society of Philadelphia, Sept. 1862.]

Additions and corrections to the paper entitled:
"On the CYNIPIDÆ of the North American Oaks and their Galls."

BY BARON R. OSTEN SACKEN.

Since the publication of my paper on the *Cynipidæ* of the North American Oaks (Proc. Entom. Soc. Phila. Oct. 1861), I have had occasion to make some additional observations, which serve to complete and often to correct, the statements of that paper.

It requires a particularly favorable situation to be able to pursue observations of this kind with some hope of attaining a certain completeness. My position in Washington, although affording me some facilities, did not always allow me to attain the accuracy which I desired. My removal to New York will probably deprive me for a long time of any opportunity of pursuing my observations. I prefer therefore, to publish now those I have on hand, following the conviction, already expressed before, that observations of nature should be made known without waiting too long for their further accumulation. The reader favorably situated may perhaps find among mine, incomplete as they are, some useful hints and suggestions. The subject is so extremely interesting and attractive that it deserves more attention than has been paid to it, not only in this country, but even in Europe.

All the observations, recorded below, have been made in Washington, unless otherwise mentioned.

Those who have paid any attention to the nomenclature of the oaks of this country, are acquainted with the difficulties attending the recognition of the species, chiefly of the red-oak group, if this recognition is to be based upon single leaves or even young trees. Thus I became aware after the publication of my paper, that the tree which I had called the red-oak (*Q. rubra*) was, *in most cases*, the scarlet-oak (*Q. coccinea*), which seems to be more abundant around Washington than the other. Most of the galls, therefore, mentioned as found on the red-oak, belong very probably to the other species. In some cases, I have been able to verify this fact, last spring. Other cases, however, are still doubtful.

I. ADDITIONS TO THE PARAGRAPHS ON THE OAK-APPLE GALLS.
(l. c. No. 1 and No. 3, p. 56 and 58.)*

At the time of my previous publication, I took for the gall of *C. con-*

* This paragraph supersedes the NN 1 and 3 of my former paper, except the descriptions of *C. q. aciculata* and *Synophrus læviventris* (l. c. p. 56 and 57), which have not been reproduced here.

fluens Harris all the oak-apples filled with a spongy substance, which I found in the environs of Washington.

Already then, however, I noticed two varieties of this gall, the one with a glossy, the other with an opaque surface (Compare l. c. p. 56).

These two varieties proved since to occur on two different kinds of oaks and therefore, very probably, to constitute two species, although the gall-flies, obtained from them, hardly show any difference. The gall-fly from the oak-apple No. 3 (l. c. p. 58), which I did not know at the time, but for which I proposed by anticipation the name of *C. q. inanis*, has also been reared by me since, and likewise closely resembles the other two gall-flies. Thus we have three (or perhaps four, as will be seen below) different and easily distinguished oak-apple galls, occuring on different species of the red-oak group, but all three producing uncommonly similar gall-flies.

The fourth oak-apple gall, peculiar to the same group of oaks, that of *C. q. aciculata*, discovered by Mr. Walsh, gives a totally different fly, as the ♀ has 14- and not 13-jointed antennæ.

I distinguish therefore, at present, the following oak-apple galls and their gall-flies :—

Q. COCCINEA. *Scarlet Oak? Large, more or less round gall, not attenuated towards the basis; surface glossy; shell thin and brittle; on the inside whitish filaments radiating from the kernel to the shell.* Diameter about an inch. C. Q. INANIS O. S. (Synon. l. c. No. 3, p. 58, and probably *C. confluens* Fitch, non Harris.)

Two ♀ specimens obtained from the galls on the 20th of June, 1862, answer to the following description :—

Head black, deeply, irregularly sculptured on the front and vertex; face finely pubescent, rugose; antennæ 13-jointed, brown or reddish-brown, especially towards the tip. Thorax black, deeply, irregularly rugose, finely and sparsely pubescent; three deeper longitudinal furrows, converging towards the scutellum, may be distinguished among this rugosity; their bottom is intersected by numerous transverse ridges and wrinkles. These furrows are deepest and broadest near the scutellum; the intermediate one is gradually attenuated towards the collare; the anterior end of the lateral ones, which runs towards the shoulders, can be seen only when the insect is kept in a certain position towards the light. Near the anterior end of the intermediate furrow and parallel to it, there are smaller, rather indistinct, longitudinal furrows and ridges. The pit at the basis of the scutellum is large, divided in two by a longitudinal ridge; its bottom, although glossy, is marked with transverse ridges. Abdomen brownish-red, glossy; the large basal, in reality the second, segment (see l. c. p. 48, foot-note) is perfectly smooth, the other segments show a minute punctation; (the posterior edge of the smooth segment shows traces of a similar punctation, but they are so minute, as to be hardly

visible, requiring a strong lens to be distinguished). Legs reddish-yellow, pubescent, hind tarsi sometimes infuscated; onychia black. Wings with a brownish-black spot at the basis of the radial area; it slightly trangresses the second transverse vein, but does not touch the anterior margin of the wing.

I have found this gall more than once on young trees, belonging either to *Q. coccinea* or *Q. rubra.* (The leaves were elongate, cuneate at the basis and hardly or, at least, not deeply, sinuate; this is, I believe, one of the varieties of the scarlet oak,)

Among the specimens of my collection, I find a number of galls, collected in one locality and somewhat different in shape from the typical specimens of *C. q. inanis.* The latter are more or less globular, the leaf being, so to say, the tangent of the globe. There is no distinct point or nipple on the top. The other gall, on the contrary, is somewhat lemon-shaped, being attenuated at its basis with a corresponding elongation, ending in a minute nipple, at the opposite end. Its color is more brownish than that of *C. q. inanis;* on the inside, I did not detect any difference between both galls. The tree is also either the red, or the scarlet oak. As twelve specimens of this gall, although of different size, all show the same characters with distinctness, I can hardly believe that these are merely accidental. I obtained only parasites from this gall.

Q. COCCINEA. *Scarlet Oak. Large, more or less round gall, not attenuated at the basis, surface glossy, shell thin and brittle; on the inside with a spongy substance, surrounding a kernel in the centre.* Diameter upwards to an inch and a half. C. Q. COCCINEÆ O. S. (Syn. *C. confluens* O. S. non Harris, ex parte; gall No. 1, l. c. p. 56.)

The external appearance of this gall is very like that of the gall of *C. q. inanis.* It is more or less globular (although irregular specimens of both frequently occur), that is, not narrowed towards the basis; its surface is glossy. Internally, it is easily distinguished by the spongy mass which fills it. It seems to reach a larger size than the former gall, as among six specimens now before me, one measures an inch and a half in diameter and two others are but little smaller, whereas among eight specimens of the gall of *C. q. inanis* the largest does not much exceed an inch.

From the following gall it is distinguished by its glossy surface, its less dense and more whitish spongy internal matter, its much thinner and brittle shell and by its shape, which is more rounded on the top. From this gall I have obtained this year (about the 25th of June) only one ♀ specimen, not showing any perceptible difference from *C. q. inanis*, except that

the thorax is somewhat reddish, which is probably due to the immaturity of the specimen.

Q. TINCTORIA. *Black Oak. Large, round gall, somewhat attenuated and pointed at the top; surface more or less opaque, as if powdered or dusted; shell thick; inside, a dense, spongy, brownish substance, surrounding the kernel.* Diameter about an inch and a half. C. Q. SPONGIFICA O. S.

This is the opaque variety mentioned l. c. p. 56, under the head of *Cynips confluens.* On the 25th of May last I found four full-grown specimens of this gall on the leaves of a large black oak (*Q. tinctoria*), and have obtained, on June 15, three ♀ specimens of the gall-fly. They look exactly like *C. q. inanis*, only they are a little larger, (the gall being also larger); the three grooves on the back of the thorax seem to be deeper and more distinct on their anterior portion; the posterior part of the scutellum, immediately behind the pit, seems to be more deeply and distinctly excised; finally, the punctation on the hind margin of the large (2nd) segment of the abdomen is somewhat more distinct.

Of these galls three, taken from a high branch of the tree, can be considered as typical specimens. They are slightly oblong, that is, somewhat extended into a point at the end, although not narrowed at the basis. Their diameter is about an inch and a half. Their color is drab, sometimes spotted with brown on one side; the surface is more or less opaque, as if powdered or sericeous, and shows very little gloss. The shell is much thicker than that of the two previous species; the spongy mass is more dense and brownish.

A fourth specimen, found on the same tree, is more irregular in its shape; its surface is without any gloss and altogether drab, without brown spots. Specimens of this kind are frequently found on young shrubs of *Q. tinctoria*, the leaves of which are very rusty-puberulent beneath.

On a shrub of this kind, apparently also belonging to *Q. tinctoria*, I found, last June, three galls, resembling exactly those just described. I cut them open and obtained from two of them perfectly mature *male specimens* of Cynips; the third also contained a mature specimen, yet contracted in the shape of a pupa and the abdomen of which was consumed by parasitical larvæ.*

There is no reason to doubt that the two males thus obtained, belong to *C. q. spongifica;* but if not for the circumstance that they were found

* This fact is worthy of remark, as it proves that some kinds of parasites begin their attacks only at a very late stage of the development of the insect.

in a similar gall, they might as well be taken for the males of the two previous species, as the slight differences they show distinguish them alike from the three species of females.

These differences, (besides their longer and 15-jointed antennæ and a smaller abdomen, both being peculiar to the sex) consist, as far as I could perceive, only in the *dark brown*, almost black, and not *red* color of their abdomen, in their infuscated hind tibiæ and tarsi, in a somewhat deeper sculpture of the thorax and in a slightly more distinct punctation of the abdomen. These male *Cynips* also resemble the *C. q. cœlebs*, except that the latter is somewhat smaller and that the spot on its wing is also more small and paler.

Q. TINCTORIA. *Black oak. Large, round gall, broad and rounded at the top; surface smooth and glossy; shell thick; inside, a dense, brown, spongy substance surrounding the kernel.* Diameter upwards to an inch and a half. C. Q. ACICULATA O. S. (Syn. *C. confluens* Harris?)

This gall was communicated to me by Benj. D. Walsh Esq., in Rock Island, Ill.

The specimens which I received from him can at once be distinguished from the gall of *C. q. spongifica*, by their smooth, glossy surface and their subglobular or short-oval form, their basis being slightly attenuated, their top, on the contrary, being broad and rounded. Otherwise, their thick shell and their dense, brownish spongy substance reminds of *C. q. spongifica*.

Mr. Walsh noticed their appearance in summer (about July). The gall-flies usually remain in the gall through the winter and escape in the spring; sometimes however, especially when the weather in the fall is unusually warm, the flies leave the gall already at that season.

The synonymy of this species with *C. confluens* Harris, supposed by Mr. Walsh, is founded on the occurrence of their galls at the same season, and on the statement of Mr. Norton about the agreement of *C. q. aciculata* with the original specimens of *C. confluens* in Dr. Harris's collection. But if Dr. Harris's gall-fly really lives on the red oak (*Q. rubra*), its great resemblance to *C. q. aciculata*, occuring on the black oak (*Q. tinctoria*) would no more be a proof of their identity, than the great resemblance of *C. q. inanis* and *spongifica* is of theirs. The two latter gall-flies, although almost perfectly similar in appearance, occur on different oaks and produce quite different galls. It may be that the true *C. confluens* Harris, although closely resembling *C. q. aciculata*, produces on the red oak a

gall, sufficiently different from that of the other species, to be distinguished by constant characters. The synonymy of both therefore, although probable, seems to require further confirmation.

The gall-fly *C. q. aciculata* has been described l. c. p. 56. Its antennæ are 14-jointed, the last joint being separated from the penultimate one by a suture as distinct as that of all the other joints; the 14th joint is very slightly longer than the 13th, and without any apparent transverse impression. This character, common to *C. q. aciculata* and to *C. q. centricola* (of the oak-apple on *Q. obtusiloba*) distinguishes these species at once from *C. q. inanis*, *spongifica* and *coccineæ*, where the last (13th) joint of the antennæ is almost twice as long as the preceding, and shows two indistinct transverse sutures, foreshadowing the 14th and 15th joints of the ♂. The structure of the abdomen of these two groups of gall-flies is also very different. Seen from the side, it appears in *C. q. aciculata* and *centricola* very slightly convex above, the line of its back not rising abruptly above the petiole; the principal curve in the outline of the abdomen is on its under side, so that its side-view is not unlike that of the seed of a *Desmodium*. In *C. q. inanis* and the two other species, on the contrary, the abdomen, seen from the side, appears as convex above as below, its dorsal line rising steeply above the petiole. In the former group the largest or 2nd joint (the petiole being taken for the first) is comparatively longer, occupying almost $\frac{2}{3}$ of the length of the abdomen, whereas in the other group (*C. q. inanis* etc.) it only reaches its middle. These differences prove that these two groups should, in a rational systematic arrangement, form two genera. It is also worthy of remark that both species of one group (*C. q. aciculata* and *centricola*) are produced by *autumnal* galls, and escape either late in the fall, or remain in the gall through the winter, whereas, the species of the other group all belong to *vernal* galls, the gall growing with the leaves and the fly passing through all the stages of its growth between the earliest spring and the end of June.

To the four oak-apple galls just described, have to be added that of *C. q. centricola* O. S., on the post-oak (l. c. p. 58, gall No. 4) and that which I found once on *Q. nigra*, the black-jack oak (see l. c. p. 53, line 14). I have not found it since, but possess in my collection a specimen of a gall-fly, closely resembling *C. q. inanis*, *spongifica* and *coccineæ* and distinguished only by a much more distinct punctation of the abdomen, which specimen, if I remember right, was reared from that gall. (Unfortunately I lost the label indicating its origin.)

I conclude the foregoing descriptions of oak-apple galls, by a synopsis of those at present known to me. I omit the species growing on the black oak, as I know it but imperfectly.

With the spongy substance inside.

Shell thick; spongy substance very dense.

Broad and rounded on the top; surface smooth and glossy; autumnal gall on *Q. tinctoria:* **C. q. aciculata** O. S.

Attenuated and pointed on the top; surface more or less opaque, as if powdered or dusted; vernal gall on *Q. tinctoria:* **C. q. spongifica** O. S.

Shell thin and brittle; spongy substance less dense.

Rounded, almost globular; surface glossy; vernal gall on *Q. coccinea:* **C. q. coccineæ** O. S.

With the filaments radiating from the kernel to the shell; the latter thin and brittle.

More or less globular, not attenuated towards the basis; surface glossy; vernal gall on *Q. coccinea* (or *Q. rubra*)*:* **C. q. inanis** O. S.

Somewhat lemon-shaped, that is, attenuated at both ends, with a distinct nipple on top; perhaps a variety of the preceding, as it occurs apparently on the same kind of oak? Gall-fly unknown.

Perfectly globular, smooth, smaller than all the preceding galls, not drab, but more reddish-yellow when ripe; shell although thin, but harder; filaments on the inside more dense and silky; autumnal gall on *Q. obtusiloba:* **C. q. centricola** O. S.

II. General remarks on the Oak-Apple Galls.

The foregoing chapter records my recent observations on the oak-apple galls of this country. These observations being, however, yet incomplete, leave open several questions to which I now call the attention of future observers. Such questions are:—

1. Are *Cynips q. inanis, C. q. coccineæ* and *C. q. spongifica* one and the same species?
2. Have the gall-flies of the oak-apples one or two yearly generations?
3. The question of the sexes.

1. Are Cynips q. inanis, C. q. coccineæ and C. q. spongifica one and the same species?

We have seen above, that these gall-flies are so similar that I could not find any important characters to distinguish them. Still, it does not follow hence that such characters do not exist. The comparison of a larger number of specimens would probably lead to their discovery.

The supposition that they *are* the same species would involve another one, that the difference between the galls described under the above names is merely due to the organic reaction of different kinds of oak against the sting of one and the same insect. It is obvious however, that this last supposition must be dropped if it is proved that *C. q. coccineæ* and *C. q. inanis* both occur on *Q. coccinea*, of which, as shown already, I am as yet uncertain.

Another fact apparently proving that they are really different species, is the close resemblance of *C. q. cœlebs* ♂ to the male of *C. q. spongifica*. The former is only smaller, otherwise it does not differ from the latter more than the females of the three species in question differ from each other. Now *C. q. cœlebs* seems to be undoubtedly a different species, as its spindle-shaped gall occurs also on a species of oak about which I am uncertain whether it is *Q. coccinea* or *rubra*. Thus we have *three* different galls, occuring, at the utmost, on *two* kinds of oak, so that, by all means *two* of the galls, and perhaps all the three grow on the *same* kind of oak. It seems obvious, hence, that gall-flies, however similar they may be, must belong to different species if they produce different galls on the same tree and that, at the same season. Mr. Ratzeburg (in his work: *Forst-Insecten*) asserts, from personal observation, that a species of *Cynips* produces the same gall even on different kinds of oak. The european *C. fecundatrix* of the *Quercus pedunculata* gave this result, when it attacked some american oaks in his garden.

For all these reasons, I believe, therefore, that *C. q. inanis*, *coccineæ*, *spongifica* and *cœlebs* are different, although closely allied, species of the same genus.

2. Have the Gall-Flies of the Oak-Apples one or two generations?

If they have but one generation, what becomes of the gall-flies escaping in June and the larvæ of which begin to develope nearly a year later, in the buds of the following spring? They may lay their eggs in the buds destined to be developed on the next year, which eggs may remain dormant, till the buds begin to grow. But this remains to be proved. I do

not recollect now having observed any instance of the same kind of oak-apple being sometimes *vernal* (that is, beginning to grow early in the spring, together with the growth of the leaves and producing the fly towards midsummer) sometimes *autumnal* (that is, reaching its full growth later in the summer or in the fall; the fly either escaping late in the fall or remaining in the gall till the following spring). In my former paper I said on p. 56 "I am inclined to agree with Dr. Fitch, who supposes that there are annually two generations of this fly (*C. confluens*)." But I do not remember now whether I founded this opinion on a fact or on a mere probability, and rather believe the latter, as otherwise I would have recorded that fact. The question remains, therefore, undecided.

3. Sexes of the CYNIPIDÆ.

When I first reared *C. q. cœlebs* ♂, its resemblance to the females obtained from the oak-apples, which, at that time, I called *C. confluens*, started the idea in my mind that they might belong together and that the question of the sexes of the *Cynipidæ* might thus find its solution in the occurrence of the males in galls different in shape from those of the females. The discovery of the four exceedingly similar species recorded above diminishes the importance of the resemblance on which I have based my hypothesis. The latter is moreover apparently altogether unsettled by the rearing of *male specimens* of *Cynips* from oak-apples. I now possess ♂ and ♀ of *C. q. spongifica*, and Mr. Walsh has reared a ♂ of what seems to be *C. q. coccineæ*. It follows hence that if ♂ and ♀ gall-flies can be reared from oak-apples, the as yet unknown ♀ of *C. q. cœlebs* may also be obtained from a spindle-shaped gall, resembling that of the male. It follows also that the gall-flies, produced by the *vernal* oak-apples of *C. q. coccineæ, inanis* and *spongifica* do *not* belong to the agamous genera of Hartig. The case is different with the *autumnal* oak-apples. Mr. Walsh informs me that he has now reared over 100 *Cynips aciculata* from oak-apples gathered in the fall, without a single ♂ among them. I have shown already (p. 246) that this species, as well as *Cynips q. centricola* O. S., which is also produced by an autumnal oak-apple, both belong to a genus different from the above vernal gall-flies. This genus therefore must be the true agamous *Cynips sensu strictiori* of Hartig and the question of the male sex remains open for it.

III. ADDITIONS TO SOME OTHER GALLS DESCRIBED IN THE PAPER ON THE CYNIPIDÆ ETC.

TO NO. 5. CYNIPS QUERCUS PISUM FITCH (l. c. p. 59).

Last winter Dr. Morris, in Baltimore, gave me an oak leaf, apparently that of a white oak, with several galls on its underside, resembling very much those of *C. q. pisum* Fitch, only that the intervals between the cracks of the net-work were less convex, so that the galls seemed somewhat smoother. On opening the box which contained them, on the 7th of January, I found a wingless gall-fly walking in it. I immediately cut one of the galls open and found that it contained two other similar apterous flies, both alive. Each gall, like those of *C. q. pisum*, contained two cavities, separated by a partition. I am unable to decide whether these gall-flies are the true producers of the gall or merely parasites. The three gall-flies were females. Not knowing exactly to what genus this species should be referred, I call it provisionally :—

Cynips pezomachoides n. sp.—*Brown, mixed with reddish on head and thorax; legs reddish; wings rudimental; length about* 0.12.

Head brown on front and vertex and in the middle of the face, reddish around the eyes; antennæ 14-jointed, brown, somewhat mixed with reddish at the basis, but little shorter than the body; sculpture of the head hardly apparent. Thorax comparatively small, reddish on the back, brown on the pleuræ and the shoulders; finely pubescent; wings reduced to the size of small scales; scutellum small, without any apparent basal pits; its tip somewhat pointed and recurved upwards; feet reddish; basal part of the coxæ brown; the middle of the femora, the external side of the tibiæ and the tarsi, especially their tip, more or less brownish; last joint of tarsi rather large. Abdomen dark brown, shining, with a somewhat bluish (opalizing) reflection. The large 2nd (apparently first) segment, with a yellowish spot on each side. The four following segments are short, slightly, but gradually diminishing in length, the last of them bears below a short double projection, with a fan-shaped pencil of yellowish hairs. The following (in fact the 7th) segment is longer than the preceding but, being narrower, forms an abrupt angle with the hind margin of the latter; it is sparsely pubescent on its surface; the eighth segment above is connected with the preceding by a triangular, whitish membrane; the ovipositor is short and bears a few hairs.

Three ♀ specimens.

TO NO. 6. CYNIPS QUERCUS TUBICOLA O. S. (l. c. p. 60).

On the first of March, 1862, I obtained a new brood of this insect, from galls collected in autumn. The coloring of the body is variable, being more or less mixed with brown; some of the specimens are altogether dark brown. The antennæ appear to me now 14-jointed and as the abdomen

has the same shape as those of *C. q. centricola* and *aciculata*, it is probable that *C. q. tubicola* has a generic affinity with them, the more so as all these galls are autumnal and produce only females.

To No. 11. CYNIPS QUERCUS PALUSTRIS O. S. (l. c. p. 63).

Galls perfectly similar to those described as occuring on the pin-oak, were observed by me this spring on *Quercus falcata*, *tinctoria* and *coccinea*. I succeeded in rearing the gall-flies from the two former and could not discover any perceptible difference between them and that of *Q. palustris*, so that my description applies to all. Still, I do not consider my inability to distinguish them as a proof of their specific identity.

My description stated erroneously that the antennæ are 15-jointed *in both sexes*. In reality they are, as they ought to be, 14-jointed in the females. The last joint, however, is, in most specimens, distinctly divided in two by a slight annular incision. As this incision is more distinct in dry specimens, this was the cause of the error in my description, which I became aware of, as soon as I obtained fresh specimens. In the same way female gall-flies with 13-jointed antennæ generally have an indication of *two* subdivisions on their last, elongated joint.

Mr. Walsh, in Rock Island, writes me that he also discovered the gall on *Q. tinctoria*. He became likewise aware of my error as to the number of joints of the ♀ antennæ.

IV. Oak-Galls not mentioned in the paper: On the CYNIPIDÆ etc.

The following galls have been partly observed by myself, partly communicated to me by other persons since the publication of my paper on the *Cynipidæ*. About some of them, as will be seen below, I am not quite sure, whether they are really the produce of this class of insects.

Quercus palustris. *Pin Oak. Woody knots on the limbs, emitting pale yellow, conical, brittle projections.* Cynips quercus cornigera n. sp. (as yet unknown).

Of all excrescences on oaks in general, the present one, wherever it occurs, is perhaps the most conspicuous, as by its abundance it deforms the tree and seems to cause considerable injury. (It has already been alluded to l. c. p. 55, foot-note.) It consists of woody knots on the limbs, looking usually as if many of them were closely packed together and thus forming

an oblong, woody irregular mass, sometimes two inches or more long. Its most striking character are its slightly curved conical projections, hollow on the inside, which bud forth from all sides of the gall. On dry, dead galls, these horn-shaped projections are for the most part broken off, so that their bases alone are visible, projecting like short tubes from the cracks of the woody tubercle. In order to be able to designate this gall, the development of which I have not been able to investigate completely, I give its as yet unknown originator the provisional name of *C. q. cornigera* n. sp.

After having very frequently observed dead galls of this kind, I finally succeeded on the 13th of May, 1862, to find some young and growing ones. They were of moderate size; their back was greenish and their wood soft and succulent. The conical projections were just beginning to bud forth; when laid bare, by removing with a knife the wood around them, they appeared to extend deep inside of the gall, almost down to the twig. Their color was whitish, their consistency soft, apparently fibrous, and not woody. At that time, they were not hollow yet, and I could not find any larvæ in them. When I brought the galls home, numerous gall-flies, evidently parasitical, began to escape from them. They emerged from hollows in the woody substance between the horn-shaped bodies and had nothing in common with the latter. They resemble the *Cynips* (Synerges?) *oneratus* Harris and evidently belong to the same parasitical genus. When I visited the same spot during the latter part of June, I found some of the horn-shaped bodies already projecting about one-tenth of an inch; their substance had become harder and more woody; their inner end had become club-shaped, distinctly isolated from the surrounding wood, so that the whole of these bodies could be easily removed by cutting away the wood around them. On the inside, the inner end was hollow and contained a small larva. This larva is probably that of the true gall-producing *Cynips*, but, unfortunately, I was prevented from watching its growth further.

Cynips (Synerges?) lignicola O. S.— Yellow, black spot on the vertex; upper part of thorax and of the abdomen black; length, ♂ about 0.1; ♀ 0.12.

Head pale yellow with a black spot on the vertex; tips of mandibles black; ♂ antennæ 15-jointed, the third joint with the usual excision below; ♀ antennæ 13-jointed, the last being elongated and showing two slight subdivisions. Collare and pectus yellow; upper and hind part of the thorax black. Legs, including the coxæ, yellow, onychia brown; abdomen brownish-red, black above; it consists apparently of a single, smooth, shining segment, the following segments being

contracted under it, so that its posterior margin projects beyond them. The neck (or first segment) of the abdomen is turgid and longitudinally grooved. The wings are hyaline, the radial area closed; the stout veins pale yellow; the areolet narrow, triangular, its two anterior sides rather indistinct, almost obsolete; the origin of the cubital vein (from the first transverse vein) is obsolete.

Numerous ♂ and ♀ specimens.

Cynips oneratus Harris is somewhat larger than this species, it has a black spot on the pectus, so that the middle coxæ are inserted on a black ground; the yellow color is not strictly confined to the collare, as in *C. lignicola*, but extends across the suture on both sides of the dorsum of the mesothorax; at the same time the black of this dorsum encroaches anteriorly on the middle part of the collare, reaching the head; the abdomen is more light yellow, and the black on its upper part is less extended. These characters belong at least to the only specimen of *C. oneratus* in my possession.

Quercus palustris. *Pin Oak. Rounded, woody gall on the upper side of the leaves, along the principal ribs.* Diameter upwards to 0.4 to 0.5. Gall-fly unknown.

These excrescenses, occuring frequently in autumn, vary in size from 0.15 to 0.4 or 0.5; most of them, however, are about 0.2 or 0.3 long and narrower than their length. Their color is brownish, sometimes more or less yellow, or reddish or with a grey efflorescence; their surface has irregular, more or less deep wrinkles, according to the age or size of the gall; otherwise it is smooth, and has nothing of the deep and regular sculpture of *C. q. pisum*. They somewhat resemble the gall of *Cecidomyia symmetrica* O. S. (see Monographs of N. A. Diptera, p. 200), but project only on one side of the leaf; besides, their outline is more regularly rounded and less deeply cracked. When cut open they show several (commonly three) cells, divided by partitions, somewhat converging towards the middle of the base.

I am not sure whether they are produced by a *Cynips*, the more so as *Cynips*-galls usually occur *on the under side* of the leaves. (This proved afterwards to be a Cecidomyia)

Quercus palustris. *Pin Oak. Round, wart-like, rusty-puberlent excrescences on the upper side of the leaf, growing several together.* Diam. of single ones about 0.1.

These galls are not unlike those of *C. q. verrucarum* O. S. (l. c. p. 61, No. 9) of the post oak and similar galls, found on the white and the swamp

chestnut oak, with the important difference, however, that they occur on the upper side of the leaf, whereas, the others are found on the under side. This makes me uncertain, whether they are the produce of *Cynips* or of *Cecidomyia*. I had no opportunity of observing fresh specimens, as those in my possession were communicated to me by Dr. Foreman, who had found them in Maryland. I did not find anything in the hard kernel of those which I cut open.

QUERCUS PRINOS, var. BICOLOR. *Large gall, at the tip of twigs, consisting of a number of wedge-shaped bodies, fastened by their pointed ends to a common centre.* Diameter about an inch and a half. C. Q. STOBILANA n. sp. (as yet not reared).

This gall, one of the most remarkable in my collection, was kindly communicated to me by Dr. Samuel Lewis, in Philadelphia, as found on young branches of this oak, in Hoope's Garden, near West Chester, Penn. For another specimen I am indebted to Dr. Morris, in Baltimore. These specimens measure rather more than an inch and a half in diameter and look somewhat like the cones of some kinds of pine, for instance, of the scrub-pine, as they consist of a number from 20 to 25 or more of wedge-shaped bodies, closely packed together, with their pointed ends attached to a common centre. These wedges are hard and corky and break off very easily when the gall is dry. Each of them contains a hollow kernel with a plump, large larva inside. This gall is evidently produced by the sting of the insect on the single leaves of a bud, each leaf growing into the shape of a wedge. I did not succeed in rearing the larvæ, which were still living when I received the gall. I call the *Cynips* by anticipation *C. q. strobilana*.

QUERCUS PRINOS. *Swamp-chestnut Oak. Globular galls on the under side of the leaf, along the principal ribs.* Diameter upwards to 0.3. Gall-fly unknown.

They were communicated to me by Dr. Foreman, who found them in Maryland. Not having seen any fresh specimen, I can only describe the dry and somewhat shrivelled ones. Their surface is finely downy, which gives them a peculiar brownish-cream-colored shade. They contain a kernel in the middle, nearer to their bases, from which numerous woody fibres radiate toward the stout woody shell. They occur in numbers on the same leaf, a moderate sized leaf which is in my possession, bearing eight of them, the largest of which has 0.3, the smallest hardly 0.1 in diameter.

I have no doubt, on account of their structure, that they are the produce of a *Cynips*.

QUERCUS OBTUSILOBA. *Post Oak. Clusters of small, somewhat bell-shaped, petiolate, greenish galls on the under side of the leaves, along the midrib.*

Their shape may be compared to that of the flowers of *Vaccinium.* They are attenuated at the basis into a short petiole, fastened to the midrib of the leaf; the opposite end is truncated, the truncature being excavated; the length, from the foot of the petiole to the truncated end, is from 0.12 to 0.15. They grow in numbers, sometimes of ten or more together, so that six, for instance, form a row on one side of the midrib and four or five on the opposite side. When found by me on the tree in October, 1861, these galls were pale green; the dry specimens are brownish. Inside of each was a small whitish larva, probably of a *Cynips.*

QUERCUS ALBA. *White Oak. Clusters of small, round, reddish galls on the petioles of the white oak leaves; inside compact, with a hard kernel.* Diameter about 0.15.

Found quite abundantly in October, 1861. I did not describe them at once and the specimens now before me are brown and shrunken. The kernels of those which I opened at that time seemed empty. Still, I believe that the galls belong to *Cynips*, as I found in the box, containing them, a parasitical Cynipideous insect, apparently escaped from them.

QUERCUS ALBA. *White Oak? Large, round gall of a hard corky substance, growing on the branches; a round, hollow space in the centre.* Diameter 0.75–0.95. CYNIPS QUERCUS JUGLANS n. sp. (as yet unknown).

I found a couple of these galls in winter, on the ground, under an oak, the species of which I was unable to ascertain. Afterwards, Mr. Hitz, of the Maryland Agricultural College, communicated to me a number of these galls, with the statement that they grow on the branches of the white oak. All these galls, as well as those found by myself, were somewhat shrunken and wrinkled on the surface, probably from the effects of dryness. They are easily distinguished from the galls of *C. q. globulus* Fitch by their large size and their much harder substance. It requires some effort to cut them open, whereas, the dry galls of *C. q. globulus* can be easily cracked. For the same reason the kernel of the latter gall can be more easily detached from the surrounding corky substance, than that of the other gall. The greater part of the galls which I cut open contained a cluster of small

evidently parasitical larvæ. In two or three, however, I found a single Cynipideous larva. I did not succeed in rearing it, but obtained several kinds of parasites.

QUERCUS COCCINEA. *Scarlet Oak. Round, somewhat oblong, hollow, pale greenish-yellow gall on the under side of the leaf, slightly projecting on the opposite side; internally, an oblong kernel, kept in its position by filaments, radiating towards the shell.* Diameter of the gall about 0.25.

This gall occurs frequently along the margins of the leaf, although sometimes in the middle, near the principal ribs. The shell is rather thin; the kernel 0.1–0.15 long, oblong in shape. Having found this gall in June, I obtained only a parasite.

UNKNOWN OAK. *Round gall of a hard, corky substance, growing on the branches, its tip drawn out in a point; a hollow kernel in the centre.* diameter of the full-grown specimens 0.4–0.5.

These galls were communicated to me by Dr. Morris, in Baltimore, Md. The branches to which they are attached, belong apparently to an oak (they have no leaves). The galls are not unlike those of *C. q. globulus* Fitch in size and structure; only instead of being altogether globular, their tip is extended into a point; their color is more reddish. They are attached in the same way to the young branches, only they seem to occur in much larger numbers crowded together. Whereas, the galls of *C. q. globulus*, observed by me occur either singly, or in clusters of two or three, symmetrically arranged round the limb; one of the branches given to me by Dr. Morris, which is 6 inches long, bears 19 of the galls of the other kind, crowded together in irregular clusters of full-grown and abortive specimens. Another branch 3 inches long bears 9 specimens.

From this gall I have reared a parasitical Cynips and another parasitical hymenopteron.

QUERCUS NIGRA. *Black-jack Oak. Round mass, resembling wool, on the twigs, with numerous seed-like grains inside.* CYNIPS QUERCUS OPERATOR O. S.

This gall resembles very much the beautiful gall produced on the white oak by *C. seminator* Harris (l. c. p. 69, No. 21). When fresh and growing, it also consists of whitish filaments, forming a white, round body with beautiful pink spots. The inside also contains seed-like kernels. I found the gall in June, on young, flowering branches and obtained on the 23rd of that month the gall-fly which I call:—

Cynips quercus operator n. sp.—Reddish; posterior part of the abdomen brownish; wings without discal areolet; ♂ antennæ 14-, ♀ 12-jointed; length of ♂ 0.1, of ♀ 0.12—0.13.

Head yellowish-red, especially on the underside: tip of mandibles brown; antennæ of ♂ 14-jointed; 3rd joint distinctly excised inferiorly: the 4 following joints of about the same length, slightly shorter than the 3rd; the other joints gradually, but slightly diminish in length towards the tip; ♀ antennæ 12-jointed, gradually diminishing in length from the 3rd joint, the longest, except the last joint, which is a little longer and shows a slight indication of a subdivision in three joints. Thorax reddish, very minutely sculptured; the two usual furrows between the collare and scutellum delicate, but distinctly marked; a short groove on each side between them and the basis of the wing; an indication of a pair of other intermediate furrows beginning at the collare and not running farther than the middle of the thorax; scutellum roughly sculptured; its basal pits rather small. Feet pale reddish, except the ungues, the hind tibiæ and the base of the hind tarsi, which are brown. Abdomen brownish-red; its posterior part, especially above, more brown; large (2nd) segment smooth and shining; the other segments with a microscopic punctation. Ovipositor rather long, projecting from its elongated sheath, which is directed upwards. Wings hyaline, very transparent; areolet none; subcostal vein, first and second transverse veins, stout, pale yellowish; last segment of the subcostal vein (usually forming an angle with the remainder of the vein and running towards the anterior margin) obsolete; radial vein and latter part of cubitus pale and subobsolete; the anterior part of cubitus (between the first and second transverse veins), altogether obsolete: anal vein hardly indicated.

2 ♂ and 11 ♀ specimens.

This species is, at first glance, somewhat like *C. q. nigræ* O. S. (l. c. p. 66, No. 17) which produces a swelling on the leaf of the same kind of oak. Their resemblance consist principally in the coloring and in the neuration of the wings, which, in both species have no areolet. The differences, however, are the following (the description of *C. q. nigræ* given in my former paper may be completed from this comparison):—

C. Q. OPERATOR.	C. Q. NIGRÆ.
Size: ♂ 0.1; ♀ 0.12—0.13.	*Size:* ♂ 0.05; ♀ 0.09.
Antennæ: ♀ 12-jointed, with a distinct indication of a 13th joint.	*Antennæ:* ♀ 14-jointed; or, if the two last joints are taken for one, 13-, but by no means 12-jointed.
Abdomen: ovate, its dorsal ridge smooth, the segments being closely applied to each other;	*Abdomen:* much shorter, its dorsal ridge much more convex, the segments being at angles to each other and with intervals between their

	hind margins and the next segment;
its punctation microscopic; its color more or less reddish at the basis and on the underside.	its punctation much more distinct; its color altogether brown.
Sheath of the ovipositor long, projecting above the abdomen.	*Sheath* short, not projecting above the abdomen.
Hind tibiæ brownish.	*Hind femora* and *tibiæ* brownish.
Subcostal and *both transverse veins* pale yellowish.	These veins pale, colorless.
The subcostal forms with the second transverse vein a rounded angle; the branch usually running from it towards the anterior margin is obsolete.	The branch of the subcostal, running towards the anterior margin is distinct and well defined, although it is abruptly truncated before reaching that margin.
The *radial vein* gradually disappears before reaching the margin.	The *radial vein* abruptly stops before reaching the margin.

The aments of the same kind of oak (*Q. nigra*) are sometimes deformed by swellings, covered with white and pink filaments exactly similar to those of the gall of *C. seminator* and *operator*; I suppose, therefore, that they are produced by the sting of the latter gall-fly, although I did not succeed to watch their development.

QUERCUS VIRENS. *Live Oak. Clusters of galls crowded together round a limb, not unlike* C. q. ficus Fitch *in appearance, but much harder.*

It was communicated to me by Mr. Glover, who brought it from Florida. The specimen before me is a branch round which, on a length of 2½ inches, 21 galls are crowded together. Their shape seems originally to be round, but from being close together they have assumed all kinds of irregular shapes, the appearance of the whole cluster being well represented by Dr. Fitch's figure of the gall of *C. q. ficus.* Their color is brownish-yellow, mixed with brown. They are much harder than the galls of *C. q. ficus.* Having broken one open, I found in the kernel the remains of a *Cynips.*

QUERCUS VIRENS. *Live Oak. Woody swelling of the limb.*

The specimen, communicated by Mr. Glover, is a fragment of a branch about 1½ inches long with two such swellings; the one is rounded about

0.7 long and 0.5 broad; the other much smaller. I opened the latter and found on the inside a small empty hollow from the structure of which I have no doubt that the gall is the produce of a *Cynips*.

QUERCUS VIRENS. *Live Oak. Small, round, wooly galls on the underside of the leaves.*

They are not unlike the galls of *C. q. verrucarum* and the analogous galls, only the wool is much longer. It seems that each gall consists of a hard kernel, covered with this pale yellow wool and that they occur in numbers together. Communicated by Mr. Glover. Undoubtedly a *Cynips*.

Boston Public Library, from the Author.

12 October 1872.

THE

WHITE COFFEE-LEAF MINER

(Cemiostoma coffeellum Stainton).

A REPORT AS

Entomologist to the Government of Brazil.

BY

B. PICKMAN MANN.

[Reprinted from the American Naturalist for June and October, 1872.]

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WHITE COFFEE-LEAF MINER.*

THE observations upon which I base the following history of that insect (*Cemiostoma coffeellum*) which is the greatest enemy to the coffee-culture of Brazil, were made in the autumn and winter of the year 1871, at the fazendas of São Sebastião and Secretario, in the township of Vassouras, Province of Rio de Janeiro, Brazil.

At São Sebastião, to whose owner, my esteemed friend Sñr. Lindorf Moreira de Vasconcellos, I return my most heartfelt

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* A Report as Entomologist to the Government of Brazil.

thanks for his unbounded hospitality and kindness, my observations extended through the greater part of the month of March.

At Secretario I continued my observations until the latter part of June, aided by the sympathy and coöperation of the proprietor, Dr. Christovão Corrêa e Castro, one of the most enlightened and progressive men whom I had the pleasure of knowing in Brazil.

The acknowledgment of my deep gratitude is due also to Col. Antonio Corrêa e Castro for his tender care of me during a month when I was prostrated by severe sickness.

I have arranged my account of the insect under headings, for greater convenience to the future investigator, and have added an explanation of the less familiar words used, for the benefit of those who are not acquainted with the science of entomology.

Food-plant, and Indications of the presence of the Insect.—The caterpillar (larva) lives in the leaves of the coffee-tree (*Coffea Arabica*), where the injury done by it is shown by the presence of rust-colored blotches on the upper surface of the leaf. These blotches are sometimes almost black in the centre.

After the larva has stopped feeding, and changed to a chrysalis (pupa), the slender, white chrysalis-case (cocoon) covered with its silken web may easily be found in a fold of the leaf.

The moths (imagos) whose beautifully ornamented, silvery wings hardly cover the breadth of the little finger nail, rest upon the leaves and branches of the tree when quiet, but are easily disturbed. Then they fly actively with a jerking flight.

Scientific Name.—The name of the genus (*Cemiostoma*) is derived from the Greek words Κημός, meaning *muzzle*, and στόμα, meaning *mouth*, so that it may be translated *muzzle-mouth*. This name was given by Zeller, in the year 1848 (in the "Linnæa Entomologica," vol. iii, p. 273), because the hairs on the side of the face are so long as to cover up the mouth. It should be accented on the antepenultimate syllable. Since it is neuter in gender, because στόμα is neuter, the specific name must be neuter also. The specific name is taken from the scientific name of the food-plant, with a termination indicating the small size of the insect.

Synonyme.—The insect was called *Elachista coffeella* by Guérin-Mèneville in his memoir (to which I shall often refer hereafter), because at the time when he described it, the genus Cemiostoma had not been established, and the genus *Elachista* was still considered of such extent as to include this species.

It was referred to under the same name by Nietner in his pamphlet on the enemies of the coffee-tree in Ceylon.

Vernacular names. — Guérin-Mèneville, who described it as coming from the Antilles, called it "L'Elachiste du Cafier."*

In Brazil it is called "A Borboleta do Cafezal," the coffee-plantation butterfly or moth, but I should think it much more satisfactory to unite accuracy with definiteness by giving it the name of the White Coffee-leaf Miner, because other species of moths are found also living on the coffee-tree, and a black coffee-leaf miner (*Gracilaria? coffeifoliella*) is known in Ceylon.

Erroneous names.— This is probably the insect referred to doubtfully as a Bucculatrix (?) by Stainton in the "Entomologist's Weekly Intelligencer," vol. iv (1858), p. 70.

Imago.—The outspread wings of the perfect insect (imago) measure from tip to tip between four and six millimeters. The body is about two millimeters long. Silvery white scales cover the head and face, the body below, the upper side of the front wings, and the legs, except the tips of the first, second and fourth foot-joints (tarsi), upon the upper side of which the scales are black. In my specimens, which are not in good condition, the upper side of the hind-body (abdomen) is bare and of a yellowish brown color. The antennæ are smoky black, except at the base. The front wings are long in proportion to their breadth. On the upper side of each, at the extremity of the inner edge (inner angle) is a large steel-blue or black spot, which has a violet lustre. This spot is bordered on the sides towards the base and front edge of the wing by a golden-yellow band, which is continued toward the end of the wing. At more than half the distance from the base of the wing to the tip, arises from the front edge (costa) another golden-yellow band, with converging sides, bordered on each edge with black scales, which runs obliquely toward the black spot, and sometimes almost reaches the golden edging of that spot. Beyond an interval of about the width of this band nearer the tip of the wing (apex) arises another band of the same color, but wider and shorter, and bordered only on the inside with black scales. This band runs less obliquely toward the black spot, but does not meet the other bands. About as far beyond the second band as that is beyond the first, a line of black scales arises

* The effect upon the leaves was called "rouille" (rust), by the people of the country, who did not know to what it was due, and ascribed it to the action of the sun.

from the costa, and runs obliquely to a point at some distance beyond the black spot. Still nearer the end arises another line of black scales, which runs less obliquely, and meets the former at its termination, the two thus forming an acute angle. The inner and outer edges of the front wings, and the whole circumference of the hind wings bear long smoky-black or brown fringes. The hind wings are very narrow and pointed. They are smoky-black on both the upper and under sides.* The front wings are of the same color on the under side. From the front of the head projects a spreading tuft of silvery-white hairs. The scales behind this tuft lie smoothly back on the head. The antennæ are about three-fourths as long as the front wings, and thread-like. Their basal joints are thickly clothed with silvery hairs, which form a velvety eye-cap as large as the eyes. The eyes are black.

Pupa.— The chrysalis (pupa) is two millimeters long; of a yellowish brown color. The head is large; the eyes are black; the limbs are glued to the body; the last pair of legs extends very little beyond the tip of the abdomen. It appears to me that eight abdominal segments are visible.

Cocoon.— The cocoon is five millimeters long, slender, spindle-shaped, formed of threads of silk of a white color, which are laid lengthwise and close together upon the outside. It is open at each end with a longitudinal slit. It rests upon a flooring of silk, and is covered by a light web of white silk, which is spun across one of the furrows at the edge of a leaf. This web is a little broader at each end than in the middle, and has an opening in each end shaped like the point of a lance, through which openings the ends of the cocoon beneath may be seen.

Larva.—The caterpillar (larva) is four or five millimeters long, and seventy-five hundredths of a millimeter broad across the first ring (prothorax), which is the widest part. It is of a yellowish flesh color, partially transparent. It is flattened, and consists of twelve rings (segments) behind the head, between each of which the body is much constricted. The second and third segments (which, with the first, form the thorax,) are successively narrower than the segment in front of them; the next three segments are successively broader, and the rest of the segments (which, with the three before them, form the abdomen), are successively nar-

* Guérin says (Mém. etc., p. 15) that they are covered with silvery scales like the superiors.

rower to the end. The head is flat, rounded in front, and is frequently much retracted within the prothorax, when its lobes show through the skin of the prothorax. The jaws (mandibles) have three teeth at the end,* and are covered in repose by the upper lip (labrum). The head on each side, has two eye-spots (ocelli), of which the anterior is the larger, and about nine hairs. The three segments of the thorax bear each a pair of jointed legs; the third, fourth, fifth, sixth and ninth or last segment of the abdomen bears each a pair of fleshy projections which serve as feet, so that the larva may be considered as sixteen-legged. From each side of the back of each abdominal segment, arise three hairs, of which the anterior or shortest is directed forward, while the two others are directed backward. The third hair is twice or more than twice as long as the second, being nearly equal in length to the breadth of the segment. The thoracic segments have all three hairs directed forward; the second hair is the longest, and an additional hair arises from the outer edge of the back of each segment.

The mine.— The habitation of the larva is a mine, which is made in the leaf by eating out the soft green substance (parenchyma) between the upper skin (epidermis) and the framework of the leaf, laying the framework bare, but leaving the epidermis intact, except at the point where (I suppose) the larva enters the leaf. At this point the wound heals up and forms a lenticular scar twenty-five hundredths of a millimeter in length, and fifteen hundredths of a millimeter in breadth, raised a little above the general surface of the leaf. The epidermis which covers the mine becomes rusty brown, sometimes almost black in the centre. The excrement (frass) adheres irregularly to its under surface. Sometimes a portion of the under surface of the leaf opposite the mine also turns brown.

When the eggs are laid in sets, as hereafter to be described, the mines of the separate larvæ usually become united, and even the mines of two sets may be united into one.

One mine fifteen millimeters long and ten millimeters broad, contained seven larvæ, the scars arranged in two groups of four and three respectively. Another scar was near.

As many as five mines, all inhabited, have been found on one leaf and even eight mines made by ten larvæ, though in this case some of the larvæ had escaped.

* Guérin says (Mém. etc., p. 13) that they are bidentate.

When the larva escapes, it cuts an angular or rounded slit in the epidermis near an edge of the mine. This slit is slightly more than one millimeter across, about one and five-tenths millimeters long.

The eggs.— Before I had seen any of the insects, I was shown some eggs on a coffee-leaf, which were said to be the eggs of this moth. I was not able to describe them at the time, but I think they could not have belonged to this moth, because they seemed too large. Stainton says, however (Nat. Hist. Tin., i, 324), that the eggs of *C. scitellum*, which is in its habits one of the nearest allies of this species, are disproportionately large for the size of the insect. Guérin does not describe the eggs in his memoir.

Classification. — It belongs to the suborder of scaly-winged insects (Lepidoptera), which may be known from other winged insects because their wings are more or less covered with scales, which lap over each other like tiles on the roof of a house, and further they (in the imago state) have no visible jaws, but either have a tubular tongue formed of two similar pieces which can be rolled up like a watch-spring, or have no means of taking food.

It belongs to the tribe of cloth-worm moths (Tineina), which are all of small size, and may be known from the other Lepidoptera because their wings, which are elongated, are not split, but are fringed with long hairs.

According to Zeller (Linn. Entom., iii (1848), p. 250), the only Tineina whose larvæ make mines in leaves, and whose imagos have the head covered with entirely smooth scales, and have the lower joints of the antennæ widened into an eye-cap, are included in the genera Cemiostoma and Phyllocnistis. These genera with others, were considered by Stainton (I know not in what work) to form the family of Lyonetia moths (Lyonetidæ). The genus Cemiostoma, to which our insect belongs, is distinguished from the genus Phyllocnistis by the absence of tongue-shields (palpi) (l. c., p. 250), and by the middle area (cell) of the fore wings not being closed (l. c., p. 265).

The genus *Cemiostoma* was divided by Stainton (Nat. Hist. Tin., i, 288) into two groups, one of which has the anterior wings of the perfect insect white, while the other has these wings leaden-gray. The former of these groups, to which our species belongs, contains six species, as far as known at present. These are *C. susinellum*, *spartifoliellum*, *wailesellum*, *coffeellum*, *labur-*

nellum and *zanclœellum*. *Cemiostoma coffeellum* is the only species of the genus yet known outside of the limits of Europe.

Our species may be known from the other species of the group by the following characters: *C. zanclœellum* has not the first golden band on the costa; in *C. susinellum* this band extends across the wing, reaching the inner angle; in *C. laburnellum*, *spartifoliellum* and *wailesellum*, this band hardly reaches to more than half the distance from the costa to the black spot, and the second band is bordered on *both* edges by dark scales. Further, all the species of the group, except possibly *C. zanclœellum*, have two or three fuscous streaks on the fringe, radiating from the black spot. I can discover no such streaks in this species.

I do not find it recorded that any other species of the group, except *C. laburnellum*, breeds more than once in a year. Stainton says (Nat. Hist. Tin., i, 314) that *C. laburnellum* breeds twice.

Seasons.—The larvæ are said to attack the new leaves in early spring, and to be found from that time forth. As the coffee-tree is evergreen, it seems likely that the period of hibernation is very short or none at all. Guérin says (Mém. etc., p. 16) that the insect occurs throughout the year in the Antilles, but is more or less abundant according to the seasons.

The eggs which I have mentioned were seen on the twenty-fifth of January. The planter who showed them to me said he had seen the moths that day. I found the larvæ, pupæ, and imagos from the ninth of March until my observations ended on the twenty-first of June.

Periodicity.—Guérin says (Mém. etc., pp. 17, 43) that the eggs hatch seven or eight days after being laid. The larvæ then live about fifteen or twenty days within the leaf, after which they make their cocoons. The cocoon is spun within less than twenty-four hours after the larva has left the mine. The larva-skin is thrown off within twenty-four hours after the cocoon is completed. I did not observe how long the pupa-state continues. According to Guérin (Mém. etc., p. 13, 17), the imago comes out of the cocoon at the end of six days. It is not known how long it lives. I should judge that it lived less than two weeks, as that has been noticed to be the probable limit of life in *C. scitellum* (Entom. Monthl. Mag., iv (1867), p. 162).

The history of reproduction, and of the deposition of eggs is not known. It must have an important effect upon the longevity

of the sexes. Guérin says (Mém. etc., p. 17), that the insect is reproduced several times in the year, in the Antilles, once in about every forty to forty-eight days. This would allow for the Eggs, 7 to 8 days; Larva, 15 to 20 days; Pupation, 2 days; Pupa, 6 days; Imago, 10 to 12 days; total, 40 to 48 days.

Habits of the larva.—As soon as the larva is hatched (if I mistake not), it cuts through the upper epidermis of the leaf, and begins to eat the parenchyma. Usually it may be found under an edge or an end of the blotch, eating. I found no cast skins in the mines. The larvæ can not be considered social, although several are often found in one mine when several mines have become united. They show no signs of pugnacity or mutual destructiveness. When the larva is full-grown it escapes from the mine, and often, or even generally, goes to another leaf to make its cocoon. This it can do by letting itself drop with a thread of silk. It then makes its cocoon across one of the furrows at the edge of a leaf, on either the upper or the under surface, but oftener on the under surface. The larva places itself across the furrow, and begins a web by spinning a series of threads from one side to beyond the middle of the furrow, swinging the fore part of its body back and forth sidewise. When it has made one side of one end of its web thus, it spins a like series of threads to make the other side, without changing the position of the hind part of its body. Thus an opening is left in the middle of this end of the web, in the space occupied by the body of the larva. It then turns around, and places its body across the furrow in the opposite direction. Here it spins a like series of threads on each side of it, from the leaf to the former part of the web, leaving a similar opening in this end. It then retires beneath the web, and lays a flooring of silk. On this flooring it spins its cocoon, laying the outside threads lengthwise.

The cocoons are found in the greatest abundance on the leaves which are near the ground, and frequently on leaves which have never been injured.

Habits of the Pupa.— The larva-skin is split *longitudinally* over the middle line of the head and first two thoracic segments. The split extends from the very foremost extremity of the head to the third thoracic segment (*metathorax*), but does not enter this latter. For the certain observation of this fact, and of the manner in which the pupa-skin is burst, I am indebted to Dr. Hagen,

who pointed out to me these interesting details. The skin is then thrown off and pushed out through the posterior end of the cocoon.

Habits of the Imago.— The pupa-skin is split transversely across the back of the head (*vertex*) then longitudinally along the sides of the thorax as far as the metathorax. When the imago emerges, the pupa-skin is left inside of the cocoon, generally I think, but in some cases I have found it protruding from the anterior end of the cocoon, through which the imago escapes by pushing aside the threads. It rests on or under the leaves or branches, but is easily disturbed. "It is very lively and very agile," as Guérin says (Mém. etc. p. 16) "and flies in all directions seeking to copulate. It is seen to execute rapid bounds, and its jerking flight makes it known even at a distance." It flies in the day-time, perhaps also in the night-time.

I judge from the appearance of the scars in the epidermis, already described, that the eggs are laid unconcealed on the upper surface of the leaf, singly, or in sets of two, three or more, but not in immediate proximity, and that sometimes two or more sets are placed on the same leaf. It is not known how many eggs are laid by one female.

Abundance.— Some idea of the abundance of these insects may be given by stating that, although, as I was frequently told, they were much less destructive than usual during the year in which I observed them, yet from one tree, which I chose for an experiment as not exceptional unless by reason of its size, I picked one hundred and fifty-three leaves in the course of nineteen minutes, endeavoring at the same time to select only those leaves which contained living larvæ, and to leave those from which the larvæ had escaped. Of these leaves forty-four contained recent mines, but the larvæ had escaped; ninety contained one hundred and twenty-two mines still inhabited; the rest contained old mines or blotches made by a fungus which also attacks the leaves.

Manner of Devastation.— The injury caused by this insect is due to the destruction of the digestive and respiratory organs of the plant. The larva "absorbs the sap, obstructs the circulatory channels, and impedes the vegetable respiration" (Madinier, l. c. p. 33), thus depriving the plant of its food, or preventing the food from becoming fit to sustain life, in consequence of which the plant becomes exhausted, and either dies, or bears fewer and smaller fruit.

Amount of Devastation. — Guérin says (Mém. etc. p. 12; [Dumeril, Rapp.,] p. 33) that in the Antilles "all the coffee-trees were feeble and languishing: they bore only small and stunted fruits, their leaves were spotted or blackened, in [great] part dried up, and although dead, remaining upon the branches, * * which rendered these shrubs languishing, and had even caused the death of many of them." Madinier says (l. c. p. 33) that owing to the attacks of insects, of which this is the most noxious, the culture of the coffee-tree was abandoned in the island of Martinique. This insect is said to lessen the coffee-crop of Brazil by at least one-fifth.

Enemies: Fungus.—The leaves of the coffee-tree sometimes turn yellow at the tip or some portion of the edge. The spots thus formed increase in size until they cover the whole leaf, gradually turning to a brown color, by which time the leaf has become dried up. These spots may be easily distinguished from those made by the larva, because the two skins of the leaf which is attacked by this disease cannot be separated, and the color is more uniform, appearing equally on both surfaces of the leaf. I was told that this was the work of a fungus. It attacks leaves which have or have not been injured by the larva, but seems to find more ready lodgment on such part of the leaf as has been injured previously. It appears in these cases to kill the larva within the mine, as many mines recently begun are found to contain the flat and empty skin of the larva, with no indication of another destroyer, but I may have been misled in my judgment by seeing the interrupted labor of the Eulophus of which I will speak next.

Enemies: Parasites. — I have found two ichneumons parasitic upon the insect: one upon the larva, the other upon the pupa. I have also found great numbers of mites (Acarina) living in the mines. The first of these ichneumons, which feeds upon the larva of *Cemiostoma coffeellum*, was found several times under a small roundish blotch of a grayish-brown color (about the same in color as the fungus-spot), which was dotted with black dots, as if a lichen had grown upon it. These black dots may have been the frass of the larva, which showed through the epidermis.

Where the ichneumon had escaped from these dotted blotches, it had cut out an oval or rounded hole in the upper surface of the blotch. Once, before I broke open one of these mines from which the ichneumon had escaped, I found the pupa-skin *in situ*, with its

broken end just touching the hole, through which it could be seen. The hole was about 0·2 millimeter in diameter.

I found several of these blotches which had no hole in them, and yet I found no ichneumon within, but the larva-skin flat and empty. This led me to think that the fungus which I have mentioned may kill and exhaust some larvæ.

According to Ratzeburg (Ichneumonen der Forstinsecten, i, (1844), p. 158), this ichneumon belongs to the genus Eulophus, in the family of *Chalcididæ*. I have not been able to make a satisfactory figure of it, owing to the injured condition of the only three examples which I succeeded in preserving. It may be called *Eulophus cemiostomatis*, if it has not been previously described.

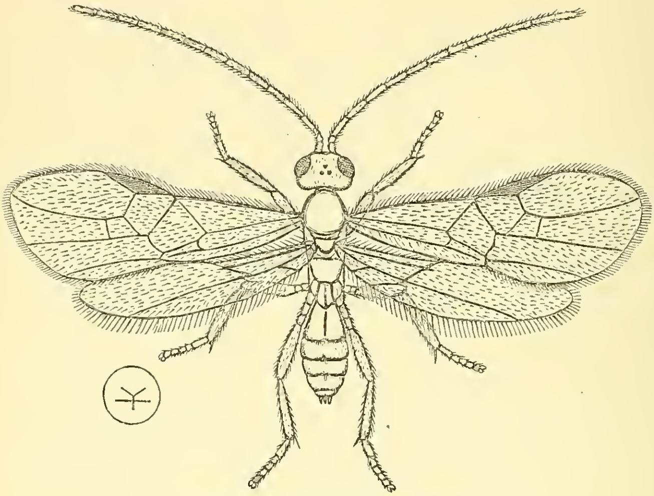
The imago is metallic green or coppery; the wings are transparent, somewhat iridescent; the fore wings crossed by a brownish cloud beyond the middle. The fore wings have no other vein than a double one near the front margin, which is bent at about one-quarter, and ends in a fork at about three-quarters of the distance between the base and the tip, sending one prong of the fork in line with the vein, and the other towards the inner angle of the wing. The inner margin of the fore wing is also thickened for a short distance near the middle; and the front margin of the hind wing is thickened along more than half its length from the base. All the wings are fringed around their margins, and the wings as well as the different parts of the body and legs are pubescent. The antennæ are eight-jointed, thinly haired; the first joint long, enlarged at the apex; the last three joints forming an ovate-conical club; the intermediate four joints ovate-cylindrical. The abdomen is elongate-oval, attached to the thorax by a broad neck, and is turned up at the sides. The tarsi are four-jointed. The length of the head and body is about 0·8 millimeter, the expanse of wings about 1·5 millimeters.

The pupa when seen through the pupa-skin seems to be longer than the imagos.—The pupa-skins look large; all are alike; one or two were sufficiently transparent to allow the occupant to be seen, which was much narrower than the pupa-skin. From one pupa-skin I hatched one of these ichneumons. I found them during all the time (April to June) in which I studied the Cemiostoma. In the one hundred and fifty-three leaves mentioned I found eight mines containing these insects. Afterwards I obtained two from a box containing leaves.

The second ichneumon parasitic on the *Cemiostoma coffeellum*, inhabits the larva while it is still in the mine, as I learned by finding an immature example dead within the thin and dried skin of a nearly full-grown larva, but I believe that it usually does not kill its victim until after the Leaf-miner has become a pupa. It then completes its work of destruction and cuts a hole in the upper side of the cocoon, through which it escapes.

It belongs to that subfamily of the ichneumons called *Braconidæ;* consequently I will call it *Bracon letifer.;* but as far as I have examined its characters, it corresponds more nearly to the genus

Fig. 130.



Bracon Parasite of the Coffee Moth.

Rogas than to any other genus described in Curtis' "British Entomology," and seems to be congeneric with, and judging by the venation of the wings, nearly related to *Exothecus exsertor*, as given in Wesmael's "Monographie des Braconides de Belgique" in the Nouvelles Mémoires de l'Academie de Bruxelles, xi (1838), p. 73, and accompanying plate, fig. 10.

The perfect insect (Fig. 130) is honey yellow, except the eyes, ocelli, and sometimes the ocellar space, which are black. The antennæ are also black, and consist of twelve slender, sub-equal, uniformly cylindrical joints beyond the scape, which seems to consist of two short, stout joints, making fourteen in all. The head is transverse; the front projects slightly beyond the eyes;

the hind margin of the vertex is emarginate, the emargination filled with the upper edge of the occiput. The three ocelli are arranged triangularly; in some examples they are approximate, in others distant, which may be a sexual difference. The neck is distinct; the back of the mesothorax sub-hexagonal, rounded, tapering anteriorly. In some of my examples the abdomen is elongate, subclavate; in others it is rotundate. I think the shape given in the figure is the most lifelike. In some examples the veins near the extremity of the wings are very feebly developed. The wings are fringed. The legs, abdomen, thorax, head, antennæ and wings are pubescent. Length 1·9 millimeters; expanse 4·7 millimeters. The immature example, or pupa of the *Bracon*, which I found as stated above, had wing pads instead of wings. These were dark, smoky black, 0·5 millimeter long. The antennæ are honey yellow, instead of black, as in the developed specimens. They lie along the breast, and reach to the end of the posterior femora, which is about the length of the whole body. The first two joints are retracted within a cavity in the front of the head, which seems to be the result of a doubling in of the front. Only the two posterior ocelli are visible, distant, and though enough of the front remains to contain the anterior ocellus, it seems as if it must be still farther forward than in the imago. The hind pair of legs is stuck straight out behind. (The abdomen is broken off.) The first and second pair of legs have the femur folded forwards; the tibia and tarsus lie towards the end of the body. This example lay within the skin of the larva, with its head towards the head of the larva.

A possible enemy is a greenish-yellow spider which draws down the edge of a coffee-leaf on the under side, and spins a light web from this edge to the surface of the leaf, leaving each end of the nest open.

Geographical Distribution. — As we have stated, M. Perrottet met these insects in the Antilles; M. Madinier found them in the island of Martinique; and I observed them in the Province of Rio de Janeiro. They are said to extend over the whole coffee-region of Brazil.

History. — Dr. Christovão, and his brother Col. Antonio Corrêa e Castro told me that the coffee-trees were first introduced into Brazil by the Brazilian Minister at Paris, who sent two plants to the city of Rio de Janeiro, where they were planted on Mount

Tijuca. From these two plants many others were obtained, which were kept in gardens as ornamental shrubs. Some of these were afterwards distributed to the plantations to be cultivated for commercial purposes. From them sprung the coffee-plantations of Brazil. Until about twenty years ago these plantations were free from all noticed pests. About that time, owing to the general exhaustion of the coffee-trees through long bearing, the Government imported quantities of new plants from the Antilles and from the isle of Bourbon, and distributed them all over the country. It was noticed during the very next year that the leaves of the coffee-tree were attacked by the larva of the moth, whose history is given here, which has ravaged the coffee-plantations of Brazil ever since. It cannot be doubted that the insects were brought from the Antilles with the plants, and that a proper examination of the plants at that time, by any person familiar with the appearance and habits of the enemies of the coffee-tree, would have prevented the introduction of so great a pest.*

Remedies.—The entomologist, like the physician, finds it much more difficult to choose a proper remedy for a disease with which he is familiar, than to trace out the nature and progress of the disease. But at this day the science of entomology, particularly in its practical application, is of such recent origin, that it suffers under a disadvantage from which the practice of medicine is free, namely, it possesses no treasury of results drawn from experience.

Bibliography. 1. Guérin-Méneville et Perrottet. Mémoire sur un Insecte et un Champignon qui ravagent les Caféiers aux Antilles. Paris. Ministère de la Marine. 1842. 8vo. pg. 40. tab. 2. Gives the history of *Elachista coffeella.*

*2. Revue Zoologique. 1842. p. 126–127. Contains a notice of No. 1.

*3. Annales de la Société Entomologique de France. 1842. T. XI, Bulletin, p. II. Contains a notice of No. 1.

*4. Zeller. Linnæa Entomologica. 1848. T. III, p. 250, 272–273; T. II, tab. II, fig. 37–39. Establishes the genus *Cemiostoma.*

*5. Stainton. The Natural History of the Tineina. 1855. Vol. I, p. 284–334, tab. 1. Contains "General Observations on the genus *Cemiostoma*," and the history of *C. spartifoliellum, laburnellum,* and *scitellum.*

*6. Nietner. Observations on the Enemies of the Coffee-tree in Ceylon. Ceylon. Published at the Ceylon Times Office. 1861. 8vo. pg. 31. On p. 24, mentions *Elachista coffeella.*

*7. Stainton. The Entomologist's Weekly Intelligencer for 1861. Vol. X, p. 110–111. "A few words respecting *Cemiostoma coffeella*; an insect injurious to the Coffee plantations of the West Indies."

8. Madinier. Revista Agricola do Imperial Instituto Fluminense de Agricultura. No. 3. p. 29 et seq. Brief notice of the Coffee-tree, containing on p. 33 an account of the habits of an insect called "*noctuella*," which must be the *C. coffeellum.*

(The asterisks before the titles of the above works indicate that I have taken the titles and references directly from the works cited).

The practical entomologist can only recommend measures to be put to the trial, and in this way gradually gather a body of experimental facts which may serve as a guide in the future.

The most obvious remedy which suggests itself is the collection and destruction of the leaves which contain the living larvæ. If this was done thoroughly, it would no doubt result in the complete extermination of the pests, a result the value of which would be incredible.

Towards this end Guérin recommends (Mém., etc., pp. 18-20) that "the branches of the coffee-trees which are loaded with [infested] leaves should be cut off in all parts of the country at one time, and burned, while the insect is in the larva state." If this were done, he says, "these coffee-trees should be cut down in such manner that the vegetation could resume its ordinary course shortly after the operation, to the end, if it were possible, of not having to regret but one crop of coffee. * * To attain this condition more promptly, the operation in question should be made with a cutting instrument, and at a height which should be determined by the proprietor himself (a metre and a half). Care should be taken to preserve here and there some young and vigorous branches, which would tend to maintain the equilibrium of the sap in all parts of the plant. * * Afterwards the development of new leaves ought to be watched with the greatest exactness, and if there should appear from place to place some spotted leaves, they should be destroyed promptly."

It will be seen that Guérin expects to cause the loss of one crop of coffee in his endeavor to exterminate the insect. Certainly the issue of the experiment, if successful, would be well worth the loss of an entire crop, but I think the same result could be obtained in a preferable way: entailing much more labor, but avoiding at the same time the loss. Probably not a single branch would be free from infested leaves, so that it would be necessary to find some other means of killing the larvæ in the leaves of those branches which remained. On the other hand, many healthy leaves would be lost, if whole branches were cut off. I think it would be better to pick off all the infested leaves, and burn them, leaving the healthy leaves to support the tree. Guérin says [Mém. etc., p. 19] that "the epoch which it would seem ought to be the most favorable for this operation would be that which immediately follows the winter season, or that during which the temperature is

the lowest, because the larva finds itself then as it were benumbed, and cannot be transformed into a moth until the return of a softer temperature." The time appointed for picking off the leaves might be, for the obvious purpose of saving labor, that at which the smallest number of old leaves remain upon the trees, if there is any such time. If the leaves were picked at such time as to take the greatest number of larvæ when they were about two weeks old, it would not be difficult to select them, as the size of the blotches would make them very noticeable.

I have made a theoretical estimate of the expense which would be incurred in picking off the leaves as I recommend, and of the relative increased yield of coffee which would result on a plantation of given size. Testing this theory by the numerical data given to me by Dr. Christovão Corrêa e Castro, and making large allowances for unfavorable circumstances, I find that the expense would be more than met by the next year's crop; but even if this should not be the case in the second year, it must be remembered that such a thorough and expensive war upon the insects never need be made more than once, and that with vigilance the trees could be kept in good order and the *increased yield maintained* continually afterwards. But vigilance must be exercised. One picking would not entirely exterminate the insects, however thoroughly it were done. The planters should also make experiments at all times, and seek other means of destroying not only this but all the enemies of their crops. They alone have the facilities for increasing and utilizing all the knowledge which can be gained upon these subjects.

Another remedy which Guérin recommends is "to kindle fires at all points of the coffee-plantations, at the time when the moths begin to issue from their cocoons. It is well known that many insects, and above all the nocturnal Lepidoptera, are attracted by light, and come whirling around a fire until they are burned there. Certainly a great number of individuals would be thus destroyed. At the same time, and to attain this object more promptly, lighted torches might be carried through the plantations in the evening. Thus a crowd of moths, hidden in places to which the light of fixed fires could not penetrate, would be attracted, and killed." Although this measure would not be absolutely efficacious, unless practised for a long time and together over the whole country, which would be difficult to accomplish, yet it would repay all the

labor expended upon it, if adopted at the time when the moths were abundant.

I will also recommend again the use of Col. Sorsby's process, which I have described at length in my report upon the enemies of Maize, drawing the description of it from the Report of the United States Commissioner of Patents for the year 1854, Part iii, p. 65.

I have thus stated all the direct means which have been suggested for the suppression of these pests. It is evident that none of them can be adopted without the expenditure of much time and labor. If other measures, less direct, could be employed, which would add to the efficiency, or take the place of those already suggested, the benefit would be great. Whatever measures are employed, however, must be founded upon certain general principles, in order to insure their success. What those principles are must first be learned, and then in what detail they can be applied. It is only in this way that we can determine whether there is any mode of opposing our insect enemies which will not cost more than it is worth.

Men gain time to advance in civilization and prosperity, by mastering the laws of nature, and converting natural forces into tools which do their work automatically as it were. Nature has provided enemies for the moth whose history we have been studying. Let us only learn how to cherish and encourage these natural friends of ours, and they will work for us thoroughly. They were made to work for us whenever we should learn how to command them.

I recommend that before the picked leaves are burned they be placed in an apartment from which the moths cannot escape, and there allowed to lie until the insects have developed. If such an apartment should be made with sides of glass, and a properly guarded entrance, it would be easy to capture the parasites while they rested on the glass, and to liberate them in the plantations, or transport them to other parts of the country where they might be needed more. At the same time the moths could be caught and killed. Or the sides of such an apartment could be made of gauze, fine enough not to allow the passage of the moths, but yet large enough to let the parasites out. Such a building could be placed in the midst of a plantation. I believe that eventually we shall have to rely mainly upon such indirect measures as a protection for our crops. It might even be worth while to undertake

a positive cultivation of the parasites, at least at those times when the race has greatly diminished in numbers. It has often been observed, in studying the history of those insects which are subjected to unnatural conditions by man's cultivation of the ground, that there is an alternation of years or of series of years in which the insects are found to be very destructive, or to have almost entirely disappeared. These alternations are partly due to the influence of the seasons, but largely to the attacks of other insects. At first the destructive insects are found to be very numerous, but an examination will show that they have already been attacked by parasites which kill them, while the parasites themselves develop. This process goes on until the parasites have so far outnumbered their prey as nearly to exterminate them, when they will no longer be able to find food, and will themselves perish. Then once more the destructive insects will have an opportunity to multiply, and so the rotation will be continued. Now it is at the time when the destructive insects have been reduced to the smallest numbers that the enlightened agriculturist will find it most practicable to adopt such measures that their numbers may never again increase. Knowing how rapidly these insects increase, when not held in control by the forces of nature, he will feel that every effort of his to stop them at the first step will be an investment of labor at compound interest for a long time to come. Who then would count the trouble? But he must know what to do.

P. S.—I desire to correct an error in the former part of this biography, kindly pointed out to me by Mr. V. T. Chambers, of Covington, Kentucky, in the current volume of the AMERICAN NATURALIST, p. 489–490. On p. 338, I said that *C. coffeellum* was 9
the only species of the genus known outside of the limits of Europe. This is a mistake. While I was in Brazil, Mr. Chambers described in the Canadian Entomologist, iii (1871), p. 23–25, a species from the United States, called *C. albella*.

As all but one of Mr. Chambers' references, in his note of correction, were wrong, I must, in order to be able to compare his species with the others of the genus, suppose it also due to negligence that he (through Mr. Stainton) describes the silvery gray metallic spot of the fore wings as apical, instead of at the inner angle. If this supposition is correct, *C. albellum* seems more nearly related to *C. coffeellum* than any of the other species, but may be known from it by having the spot at the inner angle of the fore wings silvery gray metallic, with very distinct black margins before and behind, and an indistinct pale golden streak along the base of the fringe from the costa not quite to the inner angle; while it seems not to have the two oblique lines of black scales described in *C. coffeellum*, nor the golden band which partially surrounds the spot in that species.

Mr. Chambers says also, in his note of correction, that "in the Transactions of the London Entomological Society, Ser. 2, Vol. v, pp. 21 and 27, and in Ser. 3, Vol. ii, p. 101, certainly two, and if my [his] memory is not at fault, three species [of *Cemiostoma*], are described from India." I have examined the pages to which he evidently intends to refer, and find that both the species mentioned, *C. wailesellum* and *C. lotellum*, are said to come from England.

I have had a new edition of the accompanying plate struck off, because the former one contained some errors introduced by the artist, who transferred my figures from paper to wood. Some of the figures are incomplete, because I have only drawn what I could see. This is especially the case with the larva.

EXPLANATION OF PLATE 5.

FIG. 1. Imago of *Cemiostoma coffeellum*, magnified 15 diameters.

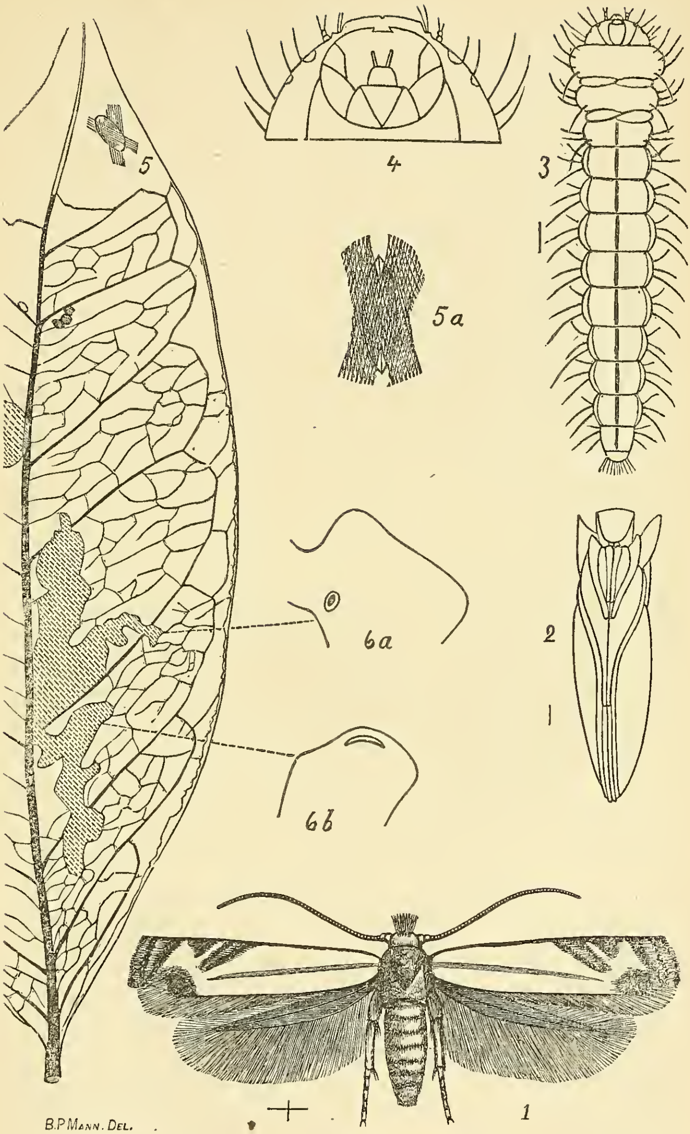
FIG. 2. Empty pupa-skin of the same, seen from beneath, magnified about 20 diameters. (The projections near the head are the broken sides of the thorax.)

FIG. 3. Larva of the same from above; the head retracted, magn. 15 diameters.

FIG. 4. Head of the larva from below, showing some of the mouth-parts, magnified about 60 diameters.

FIG. 5. Cocoon of the same, natural size; 5*a*, the same magnified 3 diameters.

FIG. 6. Leaf of coffee tree natural size, containing five mines made by ten larvæ, five of the larvæ belonging in the four mines wholly figured; 6*a*, part of a mine magnified 10 diameters to show the scar made by the larva in entering the leaf; 6*b*, part of a mine magnified 5 diameters to show the slit made by the larva in leaving the mine.



MANN, ON THE WHITE COFFEE-LEAF MINER.

(Corrected.)

10

10

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ON THE

CYNIPIDÆ

OF THE UNITED STATES

AND THEIR

GALLS.

By BARON R. OSTEN SACKEN.

ARTICLE IV.

FROM THE

PROCEEDINGS OF THE ENTOMOLOGICAL SOCIETY.

PHILADELPHIA:

May, 1865.

[From the Proceedings of the Entomological Society of Philadelphia.]

Contributions to the Natural History of the CYNIPIDÆ of the United States and of their Galls. Article 4th.

BY BARON R. OSTEN SACKEN.

(*Communicated April* 10, 1865.)

The present paper brings but very few new facts before the entomological reader. The intention which principally prompted me, in preparing it was, to give an account of the present state of the European literature on *Cynipidæ* (exclusive of *Figitidæ*), an account intended especially for the benefit of entomologists unfavorably situated with regard to access to scientific libraries and to whom this literature, scattered over many volumes of transactions of European learned societies would otherwise have remained inaccessible. At the same time, I have taken advantage of this opportunity, in order to correct several errors of my former papers, to complete some descriptions of species and to introduce some remarks, synonymous and others, suggested by the comparison of the specimens of my collection which I owe to the liberality of MM. Walsh and Bassett. In this respect my paper will afford a kind of recapitulation of the N. A. *Cynipidæ* at present known.

My correspondence with Dr. Reinhard and the exchange of specimens with him, have led me to a somewhat better insight into Hartig's system of *Cynipidæ*, than I possessed before, but have convinced me at the same time, 1st, that although most of his genera may be easily *recognizable* to European entomologists, they have never been scientifically defined; 2nd, that Hartig's system will require a considerable development, in order to be applicable to the N. A. *Cynipidæ;* this development consisting principally in the adoption of several new genera peculiar to North America and coördinate to Hartig's genera *Cynips*, *Andricus*, *Neuroterus*, *Spathegaster* and *Trigonaspis*. However, to establish new genera, without strictly defining the already existing ones, would merely increase the confusion. A simultaneous reform of the whole system will therefore be the only warrantable course to pursue.

About one hundred European gall-producing (*psenidous*) *Cynipidæ* are at present known. The number of American species has not quite reached fifty, and yet, considering the great prevalence of oaks in this country, much more abundant in species of this tree than Europe, we may expect that the number of N. A. *Cynipidæ* will far exceed the

number of European insects of this family. In view of the comparatively small number of known N. A. species and of the large additions which we can reasonably expect very soon, it would be premature to attempt now the reform above alluded to. This conclusion is still more justified by the consideration that we may likewise hope within a short time, to see new light thrown upon the still mysterious sexual question of this family, a discovery which will naturally affect its systematic distribution.

In agreement with these motives, I have adopted in this paper only three *psenidous* genera, easily recognizable by their general appearance, even in the absence of a definition, the more so, as each of them is confined to a different genus of plants. These genera are: *Cynips* (in the wider sense, in contradistinction of the genus *Cynips* Hartig, in the narrower sense, reputed agamous), which is confined to the oak; *Rhodites*, all the known species of which live on the rose, and *Diastrophus*, hitherto obtained from galls on *Rubus* and the allied *Potentilla*. As to the subdivision of the first and largest of these genera, I have confined myself to a few hints, leaving it to the future student either to follow them out or to controvert them.

The same views about the unseasonableness of a reform of the system of *Cynipidæ* have induced me to retain the primary subdivision of the family, adopted by Hartig and based upon the shape of the radial cell and the position of the areolet. This subdivision, insufficient as it is, affords the advantage of being almost coincident with the subdivision into *Psenidæ* and *Inquilinæ*, based upon the habits of the insects.

Hartig divides the gall-inhabiting *Cynipidæ* into two sections:

I. With a narrow radial area, the areolet being opposite its basis.

II. With a broad and short radial area, the areolet being beyond its basis.

The former are generally *Psenidæ;* the latter *Inquilinæ;* the exceptions, mentioned by Hartig or observed by others, will be noticed at the proper places in the sequel. Besides, most of the former (with the exception of *Rhodites*), have an open radial area; most of the latter (with the exception of several *Aulax*), have it closed. All these distinctive characters may be useful, as long as taken in connection; but how vague Hartig's definition of the two sections is, becomes very striking, if the radial area of *Rhodites* is compared with that of any species of the other section; of the two, it is certainly the former which deserves to be called broad and short; moreover, it is closed, whereas the area of *Aulax sylvestris* is open.

I will close this introductory paragraph by briefly stating the points which deserve an early investigation from those who are so situated as to be able to devote themselves to it.

1. The species *Cynips pezomachoides*, *forticornis* and *hirta*, known in their wingless form only, have been referred by me to *Teras* Hartig, because they do not possess the principal character ascribed by this author to *Biorhiza*, an almost obsolete scutellum ("scutellum subnullum" Hartig). Their scutellum is as large, and even larger, than that of the wingless specimens of the European *Andricus* (Teras) *terminalis* which I have received from Dr. Reinhard. It is singular enough. however, that the winged form of these species has not been discovered yet, and it would be worth while to breed the galls in larger numbers in order to obtain this winged form, if it exists.

2. The dimorphism of certain female *Cynipidæ* being accepted as an apparently well established fact, it remains now to be investigated how far this mode of reproduction is general in this family. The only dimorphous female as yet discovered belongs to a particular group of *Cynipidæ*, occurring on the black and red oaks only, and having certain characters in common, which probably will cause this group to be separated as a distinct genus. (The details of these characters will be given at the proper place below.) This group, as far as I can understand, is foreign to Europe.

The following questions arise at once:—1st. Is this character of dimorphism common to the whole group above alluded to? This can be easily ascertained, I think, by subjecting galls of *C. singularis*, for instance, or any other common species of the group, to the same process of observation as Mr Walsh applied to the galls of *C. spongifica*. 2d. Are the other species of the black, red and willow-oak group, species known as yet in the female sex only, dimorphous forms of some as yet unknown bisexual species? This applies especially to *C. punctata* (*podagræ*) of which more than one hundred females have been reared without any male, and to *C formosa*, which shows rather striking structural affinities to the agamous female of *C. spongifica* (*C. aciculata* olim.) 3d. Are the 39 European species belonging to the agamous genus *Cynips* Hartig, the four or five North American species belonging to the same genus, and the European agamous species of *Neuroterus*, all dimorphous females of some known or unknown bisexual species? This is the most important question of all, and the most difficult to solve by means of an *a priori* reasoning. If, on one side, we cannot but concur in the views expressed by Mr. Walsh

(Proc. etc. II, p. 448) on the improbability of an entirely agamous mode of reproduction, on the other side, it seems still more difficult to suppose that the dimorphism of the females, if it really exists in the genus *Cynips* in Hartig's sense, should have remained undiscovered for more than a quarter of a century, during which the question of the apparent parthenogenesis of this genus has attracted the liveliest interest in Europe.

I read in the last number of the *Berliner Entomologische Zeitschrift* for 1864, (page 405), that at the last annual meeting of the German Naturalists at Giessen, Professor Hartig lectured upon the parthenogenesis of *Cynips*. He said that the experiments of breeding these insects from galls made during the last twenty-five years, produced only females of the genera *Cynips* and *Neuroterus*. The females of the agamous species oviposit immediately after the completion of their development; those of the bisexual species only after copulation. He described the *receptaculum seminis* of the bisexual species; it contained spermatozoa after the copula (in *Spathegaster*.) The agamous species possess a *receptaculum*, but it contained no spermatozoa. It must be observed that there is nothing in these statements to subvert Mr. Walsh's hypothesis, and, as improbabilities are not impossibilities, it may turn out yet that some important fact, solving the vexed question, has been overlooked by European observers. Hartig reared *Neuroterus parasiticus* from the gall of a true *Cynips*. *Neuroterus* belongs to the first section of *Cynipidæ* and all its other species are pseudidous. But Hartig suggests himself that *N. parasiticus*, together with several other species, (which were all caught but not bred), may be considered as a distinct genus, on account of the perfectly smooth mesonotum, which has no parapsidal grooves.

The rather common gall of *Cynips globulus* Fitch, a true agamous *Cynips* in the sense of Hartig, can be recommended as a suitable object of observation towards the solution of the mystery. And it would be very gratifying if this solution, so happily begun by Mr. Walsh, was also completed on this side of the ocean.

New York, April 3, 1865.

Section I.

("Area radialis angusta; areolea basalis." Hartig, *Germ. Zeitschr.* II, p. 185.)

Hartig's arrangement of the genera belonging to this section is as follows:

A. Antennæ articulis inæqualibus, ultimis 7-8 brevioribus, clavam elongatam constituentibus.
  a. Scutellum hæmisphericum.
    1. Thoracis dorso villoso.
      Palpi max. 5 artic.; palpi labiates 3 art................**Cynips.**
    2. Thoracis dorso nudo, plerisque coriaceo.
      Palpi max. 5 art.; lab. 2 artic..............................**Andricus.**
    3. Thoracis dorso nudo, plerisque lævigato.
      Palpi max. 4 art., lab. 2 art...................................**Neuroterus.**
  b. Scutellum depressum, planum.
    4. Palpi max. 4 artic., lab. 2 artic..............................**Teras.**
  c. Scutellum subnullum (apterus).
    5. Palpi max. 5 art., lab. 3 artic. ultimis appendiculis conicis coronatis...**Apophyllus.**
(=*Biorhiza* Westw.)
B. Antennæ setaceæ, 15—16 articulatæ.
    6. Palpi max. 4 art., lab. 2 art.....................................**Rhodites.**
    7. Palpi max. 5 art., lab. 3 art., articulis ultimis appendiculis parvis lateralibus...................................**Diastrophus.**
C. Antennæ filiformes, 15—16 articulatæ.
    8. Thoracis dorso coriaceo.
      Palpi max. 5 art., lab. 3 art..................................**Spathegaster.**
    9. Thoracis dorso lævissimo.
      Palpi max. 5 art., lab. 2 art. articulis ultimis appendiculis coronatis...**Trigonaspis.**

This is *all* that Hartig's first article on *Cynipidæ* (Germ. Zeitschr. II, p. 176) affords towards a definition of the genera.

His second article (l. c. Vol. III, p 322) contains on pages 330 and 331 some few additional remarks, among which the only important one, is the following:—"The phrase in the tabular arrangement of the genera 'A. Antennæ articulis inæqualibus, ultimis 7—8,' etc, refers *only to the female sex*, as the males of the bisexual genera *Andricus* and *Teras* have filiform antennæ with more or less coarctate, sometimes even (*A. moniliatus*) rounded joints. These males might therefore be confounded with those of the genera *Spathegaster*, *Rhodites*, *Trigonaspis* and *Diastrophus*, if the ♂ of *Spathegaster* were not distinguishable by the abdomen, which is attached to a long peduncle, the ♂ of *Rhodites* by the closed radial area. At the same time, there exists the most remarkable resemblance between the males of *Andricus* and *Trigonaspis*, two genera which are so easily distinguished in the female sex by the structure of the antennæ. The only easily noticeable differences are that *Trigonaspis* has the single antennal joints cylindrical, *Andricus* more or less truncate-ovate; that the scutellum of *Trigonaspis* is larger, narrower, ending in a sharper point, and especially that it is more deeply excavated and more porrected over the abdomen, than in *Andricus*. The lateral tubercles of the scutellum of *Trigonaspis*

are sharper and more protruding, which gives the scutellum a more triangular shape."

About *Neuroterus* Hartig says (l. c. III, p. 338), that it can be divided into two groups, based on the presence or the absence of parapsidal grooves; in the group without them, the mesonotum is an uninterrupted, smooth, very shining convex surface; as a general rule, the mesonotum of this genus is more smooth and shining than in most species of *Andricus*. It is remarkable, adds Hartig, that two so closely allied genera as *Andricus* and *Neuroterus* should be so different with regard to their mode of reproduction. *Neuroterus* certainly belongs to the agamous genera; in *Andricus* the males are as common as the females.

Other remarks of Hartig, bearing on the subject of classification, are the following:

1. (l. c. III, p. 323). All the genera, named on the analytical table (page 5), are gall-producers (Psenidæ); *Neuroterus* alone *may* sometimes be inquilinous; *Aulax*, which belongs to the following section, he also refers *in part* to the *Psenides*. (I will discuss this question in the introductory remarks to the second section.)

2. (*ibid.*) All the above named genera are *bisexual;* with the exception of the following, which are agamous: *Cynips*, *Apophyllus and those species of* NEUROTERUS, *which are gall-producers;* (the latter circumstance is rather remarkable and perhaps suggestive! Compare above, page 334.)

3. (l. c. IV, p. 408). *Wingless females of Teras* are often bred from galls, together with winged specimens of both sexes; such specimens show a less developed thorax, but are however distinguished from *Biorhiza* Westw. (*Apophyllus* Hartig) by a larger scutellum.

4. (l. c. IV, p. 411). Hartig introduces the new genus *Synophrus*, which was not included in the tabular arrangement given above. It is characterized as follows: "Segmentum abdominis secundum* reliquis longius, area radialis angusta, areola basalis, antennæ filiformes, 14 (—15?) articulatæ; palpi maxill. 5 articulati; palpi lab. triarticulati, articulis ultimis appendiculis parvis apicalibus; facies thoracisque latera aciculata; abdominis segmentum secundum* reliquis prominens." This insect was obtained from a gall on *Quercus cerris;* its second abdominal segment seems to have nearly the same structure as that of *Synergus*.

The extracts which I have just given, contain nearly all the infor-

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* Hartig has *primum* in both cases, but in accordance with the terminology adopted by us, I change it to *secundum*.

mation which Hartig has communicated to his readers about the new genera introduced by him. He says that the great number of new species, obtained by him after the publication of these genera, were all very easily located in them. In his last paper (l. c. Vol. IV), the number of species in the different genera reaches the following figures: *Cynips* 28, *Andricus* 12, *Neuroterus* 11, *Teras* 2, *Biorhiza* Westw. 2, *Rhodites* 3, *Diastrophus* 1, *Synophrus* 1, *Spathegaster* 3, *Trigonaspis* 2.

Since Hartig, Giraud has published numerous new species of European *Cynipidæ* (Verh. Zool. Botan. Gesellsch. Wien, 1859, p. 353). He did not introduce any changes nor improvements in the system, except that he united the genus *Teras* to *Andricus*, the characters distinguishing them being insufficient, and that he established a new genus *Dryocosmus*. I will translate here the character of the genus and give a short extract on the gall-fly, which belongs to it, as well as on its gall.

Dryocosmus, Giraud.—"Maxillary palpi 5-jointed; labial palpi 3-jointed; mandibles bidentate; antennæ slightly incrassated towards the tip, 15-jointed; the basal joints of the flagellum gradually decrease in length, the sixth is at least twice as long as it is broad, the following joints are shorter, hardly longer than broad."

"Mesothorax convex, with deep parapsidal grooves, limited posteriorly by an elevated transverse ridge; scutellum hemispherical, projecting, transversely depressed at the basis and bordered on the sides by a slightly elevated ridge, which becomes weaker and almost obsolete posteriorly."

"Wings and abdomen as in the genus *Cynips;* the first (what we call now 'second') segment occupies about half of the whole length of the abdomen."

"This genus is principally distinguished from *Neuroterus* by the structure of the scutellum."

The only species, *D. cerriphilus* ♀, was obtained by Giraud from a gall on *Q. cerris*, which, judging from his description, must be somewhat like the gall of *C. cornigera* O. S., only the conical points, projecting through the woody swelling of the limb in the latter gall, are replaced here by numerous rounded, oboval or fusiform bodies, which in June pierce the outer skin of the swelling. These bodies, when fresh, are pale green, tinged with rosy and reddish and exude a sap of which the ants are very fond. The gall-fly has a smooth shining mesonotum and pleuræ, a long, narrow radial cell and a distinct areolet.

The only mention I have to make yet, in order to complete the literature of this section of *Cynipidæ*, is the genus *Pediaspis* Tischbein (Stett. Entom. Zeit. 1852, p. 141). The author obtained forty-two female specimens, in winter, from the galls on the roots of *Sorbus aucuparia*. I abstain from translating the description, as it is published in an easily accessible entomological review, the more so, as the charac-

ter of the genus is not very clearly stated. *Pediaspis* has, like *Cynips* Hartig, (in the restricted sense,) a pubescent thorax and seems in general rather closely allied to it.

In my former publications on *Cynipidæ*, I have more than once complained of the incompleteness of Hartig's definitions of the genera introduced by him. The reader may judge now for himself. For my own part, even with the aid of typical specimens, which I owe to the kindness of Dr. Reinhard, I am still unable to recognize the genera *Andricus*, *Neuroterus*, *Spathegaster* and *Triognaspis* with any degree of scientific accuracy.

Without speaking of the difficulty of counting the joints of the palpi, it is contrary to all analogy, that their number should be so variable in closely allied genera. And that the European entomologists themselves do not value this character very highly is proved by the fact that Giraud united *Teras* and *Andricus* into one genus, from want of sufficient characters to distinguish them, although *Teras*, according to Hartig, has 4-jointed, *Andricus* 5-jointed maxillary palpi. The palpi being left out, what is the difference between *Andricus* and *Neuroterus?* Hartig's phrase: "thorax bare, *usually* coriaceous" for the former, and "thorax bare, *usually* smooth," is the only, but not a sufficient, definition. In the above quoted passage, Hartig informs us that *Spathegaster* has the ♂ abdomen pedunculated; but the same is the case with *Trigonaspis!* (A specimen of this genus was sent to me by Dr. Reinhard.) In what, then, does the difference between these genera consist? As if to increase the difficulty, Mr. Hartig tells us (compare above) *that there is the most remarkable resemblance between the males of Andricus and Trigonaspis*, and, in the enumeration of the differences which follow, he makes no mention of the pedunculated ♂ abdomen. Have we to conclude from this statement that the ♂ abdomen of *Andricus* is also sometimes pedunculated?

It is the place here to bring to notice, that Hartig generally counted *one antennal joint more than necessary*, as he evidently considered as the first joint, the socket of the antenna, which is often visible below the first joint. Noticing the frequent disagreement between Hartig's statements in this respect and my own observations, I always suspected that such was the case, until recently my suspicions were confirmed, when I happened to notice Hartig's remark about *Trigonaspis* (l. c. II, p. 195): "*articulus 4 antennarum ♂ curvatus*," which evidently refers to the third joint.

The difficulty experienced by me in arranging the North American

Cynipidæ according to Hartig's system, is apparently due, besides the imperfection of the system itself, to the peculiarity of the American fauna, which may require the establishment of several new genera.

The great prevalence of oaks in this country and the great number of their species, would justify *a priori* the inference that *Cynipidæ* are very abundant. That they are not only abundant, but also very different from the European representatives of this family, may be inferred from the following facts:—1st. The group consisting of the species *C. spongifica*, *ilicifoliæ*, *cœlebs*, *singularis*, etc., quite numerously represented in North America, does not exist in Europe. 2d. The agamous genus *Cynips*, in the restricted sense of Hartig, is much more numerous in Europe than in America, as among 98 species of true gall-flies (*Psenides*), described by Hartig, and in the last publication of Giraud, 39 belong to that genus; whereas among nearly 50 North American *Psenides* at present known, only *four*, perhaps *five*, as we shall see hereafter, belong to *Cynips* Hartig.

In the introductory remarks to this paper, I have already expressed the conviction that before the North American fauna of *Cynipidæ* is better known, but especially *before the mystery of the reproduction of Cynipidæ is solved*, it would be premature to attempt a final distribution of the family in genera. Indeed, if we were not acquainted with the fact that *C. aciculata* is nothing but a dimorphous ♀ of *C. spongifica*, we would probably have located it in a different genus, on account of the peculiar structure of its abdomen, the number of joints of its antennæ, etc.

Admitting, therefore, as announced in the introduction, only three genera of *psenidous Cynipidæ*, *Cynips*, *Rhodites* and *Diastrophus*, all that I can offer at present, as to the subdivision of *Cynips*, is confined to a few hints, as follows:—

1. *C. strobilana* O. S., *C. tubicola* O. S., *C. globulus* Fitch, and *C. centricola* O. S., are the only American species at present known which Hartig would have located in his agamous genus *Cynips*. (The two former species I have communicated to Dr. Reinhard; of the two latter, I judge by analogy.) Although *C. clavula* Bassett has a pubescent thorax, a character peculiar to *Cynips* Hartig, I am not sure whether it can be considered as belonging to this genus. All these species occur within the group of the white and chestnut oaks (*Q. alba*, *prinus*, *obtusiloba*, etc.)

2. *C. seminator* Harris, which I have communicated to Dr. Reinhard, is an *Andricus*; judging by some structural analogies, *C. petiolicola* Bassett and *C. fusiformis* O. S., perhaps also *C. futilis* (*C. papillata*),

very probably belong to the same genus. These species all occur in the group of the white and chestnut oaks.

3. *C. pezomachoides* O. S., *C. forticornis* Walsh and *C. hirta* Bassett are apparently wingless females of *Teras* Hartig (a genus now united with *Andricus*); if such is the case, we may expect the discovery of winged individuals of these species. As these wingless specimens, invariably females, have always been reared in winter, may they not be dimorphous females of the winged individuals, for which we would have to look out, in such a case, in the early part of summer? *Biorhiza* Westw. (=*Apophyllus* Hartig) is distinguished from *Teras* by an almost obsolete scutellum. The three species named above belong to the group of the white and chestnut oaks.

4. *C. irregularis* O. S., *C. majalis* Bassett and *C. batatus* Fitch are distinguished by the ♂ abdomen being fastened to a rather long, linear peduncle, by the great development of the third antennal joint, which is long, stout and curved; by the smooth mesonotum, without any traces of parapsidal grooves; by the elevated hind margin of the mesonotum; by the absence of pits at the basis of the scutellum which are replaced by a transverse impression, etc. These species are evidently allied to *Spathegaster tricolor* Hartig, of which I possess specimens, the latter having an abdomen of the same structure, no pits at the base of the scutel, the same large wings, with a rather distinct cubital vein, etc. But the third antennal joint of *S. tricolor*, is linear and slender, and not much longer than the fourth; the mesonotum is very finely coriaceous, and shows faint impressions, foreshadowing the parapsidal grooves. *Trigonaspis* Hartig has the third antennal joint elongated and curved, but its abdomen, although pedunculated, has a different structure and the parapsidal grooves are distinctly marked. I conclude, hence, that the three above named N. A. species form a distinct group, allied to *Spathegaster*. *C. verrucarum* O. S., known in the female sex only, shows many points of analogy with these three species, and I should not wonder if the male proved to have a peduncled abdomen.

5. *C. spongifica* (inanis, coccineæ), *cœlebs*, *ilicifoliæ*, *singularis*, *Osten Sackenii*, and probably the gall-fly of *Q. falcata*, the gall of which was described by me, Proc. etc. I, p. 69, No. 20, form a distinct group, foreign to Europe, and which will probably have to be separated as a distinct genus. It is worthy of remark, 1st, that the galls of all these species occur exclusively on the group of the *black and red oaks*; 2d, that all these galls are built on the same plan; they are monothalamous, and consist of a globular or fusiform, comparatively thin and

brittle shell, containing a proportionally small central nucleus, kept in position either by a spongy matter, filling up the space between it and the shell, or by filaments, radiating from it. It is in this group that the dimorphism of a female (that of *C. spongifica*) was first discovered by Mr. Walsh, and it would be an interesting and comparatively easy subject for observers to investigate, whether the other species of the group likewise have dimorphous females? It would be sufficient, I think, to use for this purpose the same process which Mr. Walsh has used for the discovery of the dimorphism of *C. spongifica*, that is, to collect a large number of galls at the proper time in the spring or in early summer, and thus to obtain the two successive broods, the bisexual one in summer and the dimorphous female brood in winter or early next spring. I should not wonder at all if, in some cases, the galls producing the dimorphous females were somewhat, or perhaps even altogether, different from those producing the bisexual brood. Is not *C. formosa* Bassett, known in the female sex only and bred in winter, a dimorphous female of some other species? It is distinguished from the sexual females of the genus by precisely the same characters which distinguish *C. aciculata* (the agamous female of *C. spongifica*); its abdomen has the same shape as *C. aciculata*, and is different in shape from the abdomen of the sexual females; its sculpture, like that of *C. aciculata*, is less coarse than that of the sexual females, and also distinguished by five aciculate striæ; its antennæ have more joints than those of the sexual females.

6. *C. modesta* O. S., *C. quercus nigræ* O. S. and *C. tumifica* O. S. form again a distinct natural group, remarkable for the absence of the areolet, the peculiar, microscopic sculpture of the thorax, rendering it opaque, and the great difference in size and color between the two sexes. Their galls are polythalamous swellings of the leaf-ribs, containing many small, seed-like bodies. They occur on *Q. rubra*, *tinctoria* and *nigra*.

7. *C. operator* O. S. with 12-jointed ♀ antennæ and some other peculiarities, will probably form a new genus. It occurs on *Q. nigra*, and the same species or a similar one on *Q. palustris* and *ilicifolia*. A peculiarity in the neuration constitutes a point of relationship between this species and *C q. phellos* and *C. similis*, which, however, are distinguished by the sheath of the ovipositor being much less protruded.

8. *C. punctata* Bassett (*podagræ* Walsh) is apparently agamous; more than 120 ♀ specimens were reared by MM. Walsh and Bassett, without a single male. If such is the case, we have before us an agamous species, the thorax of which is *not* pubescent, as the thorax of the

agamous *Cynips* Hartig invariably is. The presumption is, therefore, that it belongs to a different genus, and this is supported, by the other characters, as the sculpture, the shape of the abdomen, etc. Now *C. scitula* Bassett, known in both sexes, resembles *C. punctata* very much, except that it is much smaller; it occurs, like *C. podagræ* on *Q. tinctoria*, and produces a gall which, judging by the description, is not unlike that of the latter species. These facts irresistibly suggest the impression that *C. podagræ*, its larger size notwithstanding, is but an agamous female of *C. scitula.* Again a fact for observers to investigate.

The above remarks may be summed up as follows:—

1. The species of *Cynips* producing galls on trees of the *white and chestnut oak group* (*Q. obtusiloba macrocarpa, alba, prinus, prinoides, castanea*, forming Mr. Gray's first division. *fruit ripening the first year;* compare Gray's Manual of Botany,) seem to be, as a general rule, generically distinct from the species, producing galls on the trees of the *black, red and willow oak group* (*Q. rubra, coccinea, tinctoria, falcata, ilicifolia, palustris, phellos, imbricaria, nigra;* Gray's second division, *fruit not maturing until the second year*). Thus the genera *Cynips* (in Hartig's sense), *Andricus*, *Spathegaster*, *Teras*, as far as they are recognized among the N. A. species, all occur on the white oak group, whereas most of the species belonging to the other group will probably require the establishment of new genera. Hence, the relationship with the European fauna is especially to be found in the first group, the second principally containing forms peculiar to America.

2. If any species of *Cynips* produces galls on more than one kind of oak it will always confine itself to oaks of the same botanical group. I am not aware of a single exception to this rule.*

Genus CYNIPS.

(Galls on trees of the genus *Quercus*.)

The number of species of *Cynips* in its present acceptation being now more than forty, and a number of galls having been described besides, the gall-flies of which are as yet unknown, it became very desirable to have a general synopsis of the knowledge thus accumulated, the more so as the data respecting this knowledge are scattered in several volumes. To this end, the following two tables have been prepared: 1st, an analytical table of the known species of N. A. *Cynips;* 2d, a synoptical table of the known N. A. oak-galls produced or supposed to

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*This was already written when I received Mr. Walsh's paper "*On the insects etc. inhabiting the galls of certain willows,*" (Proc. Ent. Soc. Vol. III, p. 543) and found, that by a remarkable coincidence, this author has made precisely the same observation (l. c. p. 639).

be produced by *Cynips*. At the end of these tables have been added 3d. *Remarks*, containing all the necessary references to the previous publications bearing on the subject, and some new facts, suggested by the comparison of original specimens, additional descriptions, etc.

1. The construction of the first of these tables is necessarily imperfect, owing to the difficulty of finding discriminating characters of easy and general application. Another still more evident cause of imperfection is, that of many species, only one sex is known. It will be highly desirable to have a new, corrected table published as soon as the accumulation of new facts will require it. Such a table affords the advantage of being the only means for identifying, if not with certainty, at least with some degree of approximation, the species of *Cynips* taken at large and not bred from galls. A very useful, if not indispensable addition to the table, would have been a full and comparative description of all the known species, instead of the existing descriptions differing in the degree of their completeness, often in their nomenclature and scattered in many volumes. I regret that I have not had time to prepare such descriptions.

The frequent occurrence of phytophagic varieties within the present group has induced me always to add the name of the tree to the name of the species bred from it. The name of the tree and the description of the gall being added to the description of the insect, it will be possible, in most cases, to attain comparative certainty as to the specific identity of the insect, even if its description should only be of average completeness. On the contrary, the insect alone or even the gall and the insect being described, without the name of the tree, the identification may often seem doubtful. If a species has been first found on one kind of oak and subsequently on others, I have added the name of the first kind of oak only, thus showing that the insect bred from that oak represents the type of the species. If, for instance, it is once proved that constant differences occur between *C. q. palustris* bred from *Q. palustris* and *C. q. palustris* bred from *Q. tinctoria*, the first should be considered as typical. Entomologists should be especially cautioned against rashly concluding as to the specific identify of insects bred from two galls, showing a superficial resemblance, but found on different trees.

In the analytical table No. I, those species which are nearly identical, but occur on different trees, and may thus be considered as phytophagic varieties, or incipient new species, are united by brackets.

I have also introduced a slight change in the nomenclature, which I have to account for. In my previous papers, following the example of

former writers, I have always placed the letter *q* (*quercus*) between the generic and the specific names of the *Cynipidæ* of the oak. But as this addition seems to me perfectly useless, I have omitted it now, except in cases when the name of the species is derived from the name of the oak, (as, for instance, *C. quercus nigræ* O. S.)

2. In preparing the *Synopsis of the galls* (Table No. II), I have mostly retained the subdivisions adopted in my first paper (Proc. etc. I, p. 53). Although these subdivisions are merely empirical, the table will considerably facilitate the task of determining whether a given gall has been described or not, and, in the first case, where the description is to be looked for. A scientific subdivision of the galls has to be based on physiological characters, which are not sufficiently investigated at present. As galls are apt to undergo several modifications of their appearance during the different stages of their growth, the description of a gall should represent it in the state of maturity, which is reached when the gall-fly is ready to escape. This rule should be invariably understood, unless the description is rendered still more complete by representing the successive stages of growth.

I. *Analytical Table of the known species of N. A.* Cynips.

Observation.—The numbers on the left-hand side of the specific names refer to the *Remarks*, etc. on page 350 and the following.

1. *No distinct parapsidal grooves;* mesonotum quite smooth and bare, scutellum likewise........ 2
   Parapsidal grooves distinctly marked (unless indistinct in consequence of a very rough sculpture of the mesonotum)........ 4
2. Third antennal joint equal in length to three or four of the following joints taken together; thorax of the ☿ with yellowish pleuræ. — 18. **C. irregularis** O. S. ☿. (Q. obtusiloba.) 19. **C. majalis** Bassett ☿ ♀. (Q. alba.)
   Third antennal joint equal to two of the following joints taken together, or less........ 3
3. 0.10—0.12 long........ 20. **C. batatus** Fitch ☿ ♀. (Q. alba.)
   0.05 long........ 21. **C. verrucarum** O. S. ♀. (Q. obtusiloba.)
4. Wings with a conspicuous dark brown cloud at the basis of the radial area, on the second cross-vein........ 5
   Wings without such a cloud, or, at the utmost, with a narrow, inconspicuous brown margin on the second cross-vein........ 7
5. Feet black, except the two anterior pairs of tibiæ and tarsi, which are brownish-yellow. — 26. **C. q. ilicifoliæ** Bassett ☿ ♀. (Q. ilicifolia.)
   Feet reddish or yellowish........ 6
6. Areolet distinct; ☿ 0.18 long; ♀ 0.23........ 22. **C. spongifica** O. S. ☿ ♀. (Q. tinctoria.) 23. **C. q. coccineæ** O. S. ♀. (Q. coccinea.) 24. **C. inanis** O. S. ☿ ♀. (Q. rubra.)

Areolet very indistinct; ♂ 0.14 long..................25. **C. coelebs** O. S. ♂. (Q. rubra?)

7. Areolet present (the veins, bounding it on the inside may often be nearly obsolete, still the areolet, in a certain light, is visible.)...... 8

No areolet.. 25

8. Mesonotum and scutellum clothed with a rather dense, appressed pubescence.. 9

Mesonotum altogether glabrous or seldóm with a few short, scattered, microscopic hairs*.. 13

9. Body reddish, small (0.10—0.12 long).................. 4. **C. tubicola** O. S. ♀. (Q. obtusiloba.)

Body black or brown.. 10

10. Posterior half of the abdomen pubescent........... 1. **C. strobilana** O. S. ♀. (Q. bicolor?)

Posterior half of the abdomen not pubescent.............................. 11

11. Body not more than 0.12 long........................... 5. **C. clavula** Bassett in litt. ♀. (Q alba.)

Body more than 0.15 long.. 12

12. A brown cloud in the angle between the radial and cubital veins and a couple of irregular brown marks towards the apex of the wing. 3. **C. centricola** O.S. ♀. (Q. obtusiloba.)

No clouds or marks in the space between the radial and cubital veins.................................... 2. **C. globulus** Fitch ♀. (Q. alba.)

13. Mesonotum more or less distinctly, (although sometimes microscopically) sculptured.. 14

Mesonotum smooth, shining, without any apparent sculpture (except the usual longitudinal furrows).. 23

14. Sculpture of the mesonotum very coarse and rough...................... 15

Sculpture of the mesonotum delicate.. 16

15. ♂ Antennæ distinctly 16-jointed; ♀ hind feet concolorous with the other feet, reddish; ♀ abdomen red or reddish-brown............................ 27. **C. singularis** Bassett ♂ ♀. (Q. rubra.)

♂ Antennæ 15-jointed; ♀ hind feet darker than the two other pairs, brown; ♀ abdomen black. 28. **C. Osten-Sackenii** Bassett ♂ ♀. (Q. ilicifolia.)

16. The whole pleuræ are rugose, opaque.. 17

A considerable portion of the upper part of the pleuræ is smooth and shining.. 21

17. ♀ Antennæ distinctly 15-jointed; whole body (♀) not black *nor* dark brown.. 18

♀ Antennæ 13 or 14-jointed; body (except antennæ or feet) black or dark brown 19

18. ♀ head and thorax brownish-yellow, abdomen brownish... 37. **C. ventricosa** Bassett ♀. (Q. ilicifolia.)

♀ head and thorax deep-black, abdomen bright red... 29. **C. formosa** Bassett ♀. (Q. rubra.)

19. Mesonotum with a dense, even sculpture, giving it a handsome, semiopaque appearance.. 20

Mesonotum rather shining, its sculpture perceptible under a very strong lens only.............. 38. **C. cornigera** O. S. ♀. (Q. palustris.)

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* The only possible error here is with *C. petiolicola*, which may be referred to the preceding diagnostic phrase, as its thorax has a sparse, but rather distinct pubescence.

20. Length 0.12 .... 39. **C. punctata** Bassett ♀. (Q. rubra.) 40. **C. podagræ** Walsh ♀. (Q. tinctoria.)

Length 0.07—0.09 .... 41. **C. scitula** Bassett ♂ ♀. (Q. tinctoria.)

21. The rough sculpture of the humeral parts of the collare is in distinct contrast with the comparatively smooth and finely sculptured surface of the mesonotum *19

There is no marked contrast between the sculpture of the humeral parts of the collare and the mesonotum 22

22. Scutellum finely rugose, opaque .... 7. **C. petiolicola** Bassett ♀ ♂. (Q. montana.)

Basal half of the scutellum rather smooth and somewhat shining .... 8. **C. fusiformis** O. S. ♀. (Q. alba.)

23. Scutellum deeply rugose, and therefore opaque; male abdomen not pedunculated; head of the female reddish .... 6. **C. seminator** Harris ♀ ♂. (Q. alba.)

Scutellum moderately rugose, and therefore more or less shining: head of the female black (except the face, which in *C. q. palustris* is reddish) 24

24. ♂ 0.09, ♀ 0.10 long .... 42. **C. q. palustris** O. S. ♂ ♀. (Q. palustris.)

♂ only 0.05 long .... 9. **C. futilis** O. S. ♂. (Q. alba.) 10. **C. papillata** O. S. ♂. (Q. prinus.)

25. The branch of the subcostal vein, running towards the anterior margin, is obsolete; the radial area is therefore open on the inner side 26

The branch of the subcostal vein running towards the anterior margin is distinctly marked, although sometimes abbreviated 27

26. The sheaths of the ♀ ovipositor project considerably above the dorsal line of the abdomen; ♂ of the same coloring with the ♀, both being brownish-red .... 36. **C. operator** O. S. ♂ ♀. (Q. nigra.)

The sheaths of the ♀ ovipositor do not project above the dorsal line of the abdomen; the ♀ is brownish-red or reddish-brown; the ♂ of *C. similis* is black; the ♂ of *C. q. phellos* is as yet unknown .... 32. **C. similis** Bassett ♂ ♀ (Q. ilicifolia.) 31. **C. q. phellos** O. S. ♀. (Q. phellos.)

27. Stout veins of the wings pale, colorless; head and thorax (♀) reddish, abdomen dark brown: ♂ small in size, black .... 33. **C. q. nigræ** O. S. ♂ ♀. (Q. nigra.)

Stout veins of the wings colored with brown, head and thorax (♀) brown 28

28. Antennæ uniformly brownish-yellow; length of ♀ 0.06—0.07 (male unknown) .... 35. **C. modesta** O. S. ♀. (Q. rubra?)

Antennæ darker towards the tip; length of the ♀ 0.09—0.10 .... 34. **C. tumifica** O. S. ♂ ♀. (Q. tinctoria.)

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*This brings back to *C. cornigera* O. S. This species has a small smooth space on the upper part of the pleuræ, which might mislead those who perceive it. Care has been therefore taken to arrange the table in such a manner that whichever of the two phrases under No. 16 is chosen, *C. cornigera* may be reached.

N. B.—Are not mentioned in this table the species known in their wingless form only (12. **C. pezomachoides** O. S., 13. **C. forticornis** Walsh and 14. **C. hirta** Bassett) and the species which I have not seen (11. **C. flocci** Walsh, 30. **C. sculpta** Bassett, 15. **Philonix fulvicollis** Fitch, 16. **Ph. nigricollis** Fitch, 17. **Biorhiza nigra** Fitch).

II. *Synopsis of the described Galls of N. A.* Cynips.

Observation.—The numbers on the left hand of the names refer to the *Remarks* on page 350 and the following. An asterisk near this number means that I have not seen the gall, and therefore cannot judge with certainty about its location. As some galls have been described (especially by Dr. Fitch) under the name of their guest-flies, and had to change their name since the discovery of the true gall-flies, I have mentioned their former name as *synonym of the gall*, which of course does not imply the synonymy of the insects. All the galls of the left-hand column are found on the group of the white and chestnut oaks; all those of the right-hand column belong to the group of red, black and willow oaks. This subdivision will render it easier to find a gall in this synopsis, the more so as in no instance, as yet known, has the same species of gall-fly been discovered on two species of oaks belonging to different groups. (Compare above, page 342, No 2.) Some of the galls, the gall-flies of which are not known, may prove not to belong to the *Cynipidæ* at all.

Group of white and chestnut-oaks.	**Group of red, black and willow-oaks.**

I. Galls on leaves.

A. Galls not intimately connected with the substance of the leaf, generally fastened by a small portion of their surface, and which can be removed without carrying a portion of the leaf with them, (projecting from one side of the leaf, or from the margin.)

1. Globular galls, with a kernel in the centre, kept in position by a softer substance (dry spongy, fibrous, or succulent) or by filaments, radiating from it to the shell; all monothalamous.

a. Kernel kept in position by a dry, spongy or fibrous substance.

43. Q. ~~prinus~~ bicolor; gall-fly unknown.	22. Q. tinctoria; **C. spongifica** O. S. *Syn.* of the gall: *confluens* Harris.
~~*14. Q. montana? C. hirta Bassett.~~	23. Q. coccinea; **C. q. coccineæ** O. S.

b. Kernel kept in position by delicate filaments.

3. Q. obtusiloba; **C. centricola** O. S.	24. Q. rubra? **C. inanis** O. S. *Syn.* of the gall: *confluens* Fitch, (non Harris.)

c. Kernel kept in position by a juicy substance.

	*30. Q. rubra } **C. sculpta** Bassett.
	*30. Q. tinctoria }

2. Globular or irregularly rounded galls of a hard, woody sub-

Group of white and chestnut-oaks. | **Group of red, black and willow-oaks.**

stance, hollow inside, but without distinct kernel of a harder substance; the hollow space usually divided in two or more cells.

57. Q. alba; gall-fly unknown (the same as the following?) *Syn.* of the gall *Q. pisum* Fitch?
12. Q. alba? **C. pezomachoides** O. S.
58. Q. alba; gall-fly unknown; gall *Q. erinacei* Walsh.

14. Q. prinus (var. montana). C. hirta Bassett.

44. Q. palustris; gall-fly unknown.

3. Spindle-shaped galls.

8. Q. alba; **C. fusiformis** O. S.
56. Q. prinoides; gall-fly doubtful. (*Figites chinquapin* Fitch.)

25. Q. rubra? **C. cœlebs** O. S.
26. Q. ilicifolia: **C. q. ilicifoliæ** Bassett.

4. Woolly or hairy excrescences on leaves, wartlike or irregular.

11. Q. alba? **C. flocci** Walsh.
45. Q. alba; gall-fly unknown; (*C. flocci?*) *Synon.* of gall: *Q. lanæ* Fitch.
46. Q. obtusiloba; gall-fly unknown.
21. Q. obtusiloba; **C. verrucarum** O. S.
47. Q. prinus; gall-fly unknown.
47. Q. alba; gall-fly unknown.

48. Q. palustris; gall-fly unknown.

5. Clusters of small galls growing on the underside of the leaves, or on the petiole.

49. Q. obtusiloba; gall-fly unknown.
50. Q. alba; gall-fly unknown.

51. Q. rubra; gall-fly unknown; gall *Q. decidua* Bassett.

6. Tubular galls with spines on the outside.

4. Q. obtusiloba; **C. tubicola** O. S.

AA. Galls intimately connected with the substance of the leaf, so that they cannot be taken off without carrying a portion of the leaf with them.

1. Globular, hollow, monothalamous galls.

a. With a kernel in the centre, kept in position by filaments, radiating from it to the shell (same type of structure as the galls of section A, 1, *b.*)

27. Q. rubra; **C. singularis** Bassett. *Syn.* of gall *Q. nubilipennis* Fitch (non Harris.)
28. Q. ilicifolia; **C. Osten Sackenii** Bassett.
28. Q. coccinea; gall-fly unknown.

b. With a white, cocoon-like body, rolling freely about in the cavity (on very young leaves and on buds, early in the spring).

Group of white and chestnut-oaks. | **Group of red, black and willow-oaks.**

42. Q. palustris.
Q. tinctoria.
Q. falcata.
Q. coccinea.
Q. imbricaria.
Q. ilicifolia.
} **C. q. palustris** O.S.

2. Swellings or expansions of the leaf or of the leaf-ribs, mostly polythalamous, except No. 7, which seems to be monothalamous.*

a. Juicy swellings of the blade of the leaf; of a cellular, pithy structure, when dry.

18. Q. obtusiloba; **C. irregularis** O. S.
19. Q. alba; **C. majalis** Bassett.

b. Expansion of the leaf, not juicy, with two or three seed-like kernels in the centre, kept in position by filaments.

9. Q. alba; **C. futilis** O. S.
10. Q. prinus; **C. papillata** O. S.

c. Hard, woody swellings of the leaf-stalk at the basis of the leaf, or of the principal leaf-rib.

7. Q. (prinus) ~~mont~~ana; **C. petiolicola** Bassett.
7. Q. prinoides } same insect?
7. Q. alba }
7. Q. bicolor ~~prinus~~; same gall? Insect unknown.

d. Swellings of the leaf, usually along the principal ribs; they contain numerous, seed-like kernels.

33. Q. nigra; **C. q. nigræ** O. S.
34. Q. tinctoria; **C. tumifica** O. S.
35. Q. rubra; **C. modesta** O. S.

II. Galls on branches, twigs, etc.

A. Galls of a different substance than the limb, and which can be taken off, without carrying a portion of the branch with them.

1. Monothalamous galls, mostly of a corky substance (except the gall No. 54, which is filled with a spongy substance.)

a. Each gall wedge-shaped; a number of them growing together, with the points of the wedges in the centre, form a body not unlike the cone of a pine.

1. Q. prinus (var. bicolor). **C. strobilana** O. S.

b. Galls globular, smooth, or with a nipple or point at the end.

52. Q. prinus (var. bicolor)? Gall-fly unknown.
2. Q. alba } **C. globulus** Fitch.
Q. (prinus) ~~montana~~ }
2. Q. obtusiloba } Galls similar to the preceding;—
2. Q. macrocarpa } gallfly not reared.
53. Q. alba?? Gall-fly unknown; gall named *Q. juglans* O. S.

c. Large globular gall, growing from the side of the cup of the acorn.

53. Q. rubra } Gall-fly unknown; gall named *Q. prunus* Walsh.
Q. tinctoria }

d. Subconical galls, often in clusters.

37. Q. ilicifolia; **C. ventricosa** Bassett.

e. Cluster of elongate-ovate galls.

*29. Q. rubra; **C. formosa** Bassett.

f. Monothalamous, oblong galls, filled with a spongy substance.

54. Q. falcata; gall-fly unknown.

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*The gall of C. petiolicola is certainly polythalamous.—*H. F. Bassett.* May 25th, 1865.

Group of white and chestnut-oaks.	Group of red, black and willow-oaks.

2. Woolly excrescences, with a great number of seed-like kernels inside.

6. Q. alba; **C. seminator** Harris.	36. Q. nigra, Q. ilicifolia, Q. palustris } **C. operator** O. S.

3. Bladder-like, thin-shelled, hollow, irregular galls, crowded together round small limbs.

13. Q. alba; **C. forticornis** Walsh.
Syn. of gall: *Q. ficus* Fitch.

4. Clusters of small, narrow, deformed leaves, with the gall in the centre.

55. Q. prinoides; gall-fly unknown;
gall *Q. frondosa* Bassett.

A.A. Swellings of the branches, twigs, etc., which cannot be taken off without breaking the branch.

a. Swellings at the tip of the twig.

20. Q. alba; **C. batatus** Fitch.	31. Q. phellos; **C. q. phellos** O. S.
5. Q. alba; **C. clavula** Bassett.	*32. Q. ilicifolia; **C. similis** O. S.
Syn. of gall. *Q. tuber* Fitch.	
Q. arbos Fitch?	

b. Swellings in the middle of the branch.

	39. Q. rubra; **C. punctata** Bassett.
	40. Q. tinctoria; **C. podagræ** Walsh.
	*41. Q. tinctoria; **C. scitula** Bassett.
	38. Q. palustris; **C. cornigera** O. S.
	*38. Q. ilicifolia; gall-fly unknown.

III. *Remarks supplementary to the two preceding Tables.*

a. Galls on the group of the white and chestnut-oaks.

1. C. STROBILANA O. S., Proc. etc. III, p. 690; (♀; *Q. prinus*, var. *bicolor*); the gall Proc. etc. I, p. 254. This, as Mr. Reinhard informs me, is a true agamous *Cynips*, in the restricted sense of Hartig; it belongs to Hartig's first division, which has the tip of the abdomen pubescent.

2. C. GLOBULUS Fitch, Rep. II, No. 312 (♀; *Q. alba*). Compare also O. S. Proc. etc. I, p. 68 and Bassett, Proc. etc. II, p. 328. Dr. Fitch, Mr. Walsh, Mr. Bassett and myself have found this gall on *Q. alba*. Mr. Bassett has found a similar gall, giving apparently the same insect, on *Q. montana*. Galls of the same kind were observed by me on *Q. obtusiloba* and by Mr. Walsh on *Q. macrocarpa*; neither of us have obtained the insect, however. *Cynips globulus* belongs to the genus *Cynips*, in the restricted sense of Hartig.

3. C. CENTRICOLA O. S. Proc. etc. I, p. 58 (♀; *Q. obtusiloba*). Likewise a *Cynips* in Hartig's sense.

4. C. TUBICOLA O. S., Proc. etc. I, p. 60 (♀; *Q. obtusiloba.*) Again a *Cynips* Hartig, as Mr. Reinhard, to whom I have communicated specimens, informs me.

5. C. CLAVULA Bassett in litt. (Syn. *C. q. tuber* Bassett, non Fitch). (♀; *Q. alba*). This insect, described by Mr. Bassett (Proc. etc. III, p. 685) as *C. q. tuber* Fitch, could not retain this name, as Mr. Bassett himself proves that it is *not* the insect described by Dr. Fitch, the latter being a guest-fly. I have therefore adopted the name *C. clavula*, suggested to me in a letter by Mr. Bassett himself. Although this insect has a pubescent thorax, like *Cynips* in the restricted sense of Hartig, I am not sure whether it is to be referred to this genus. The feet of my specimen are brownish-yellow and not brown, as mentioned in Mr. Bassett's description. According to this author's opinion (l. c.) this gall and that of *C. q. arbos* Fitch are produced by the same insect. Both *C. q. tuber* Fitch and *C. q. arbos* Fitch are guest-flies; (compare below, the genus *Ceroptres*).

6. C. SEMINATOR Harris, Insects etc. p. 548; Fitch, Rep. II, No. 315; O. Sack., Proc. etc. I, 69, No. 21; Walsh, Proc. etc. II, p. 465 (at the top); (♂ ♀; *Q. alba*). I had expressed some doubts about the identity of the specimens obtained by me from these galls, with those described by Fitch, as he says that the thorax of the ♀ is cinnamon-red. Mr. Walsh confirmed my doubts, venturing even the supposition that the gall-fly described by Fitch was a guest-gall-fly. I believe now to have found the solution of the difficulty. Having examined my specimens recently, after a lapse of several years, I find that the thorax of all the ♀ specimens has become reddish, whereas that of the ♂ specimens has remained black. It seems probable, therefore, that Dr. Fitch had rather old specimens before him when drawing his description. *C. seminator* belongs to the genus *Andricus* Hartig.

7. C. PETIOLICOLA Bassett, Proc. etc. II, p. 325 (♂ ♀; *Q. montana*); compare also Walsh, Proc. etc. II, p. 487; (*Q. prinus*, var. *discolor*). This is the gall which was described by me as occurring on *Q. prinus* (Proc. etc. I, p. 66); at that time I obtained only parasites from it. Mr. Bassett has found a similar gall on *Q. prinoides* (l. c. II, p. 325), giving a closely resembling fly. A number of specimens of the latter, which I owe to Mr. Bassett, are smaller, the body of the female is constantly pale brown (and not black, as that of *C. petiolicola* ♀), and, as Mr. Bassett remarks, the veins of the wings are less distinctly marked. This is again a case of a phytophagic variety, which may almost be considered as a distinct species. A similar gall on *Q. alba*, mentioned by Mr. Bassett (l. c.) produces an insect which stands to *C. petiolicola* in

the same relation as the gall-fly of *Q. prinoides*. *C. petiolicola* is very probably an *Andricus*.

8. C. FUSIFORMIS O. S., Proc. etc. I, p. 61 (♀; *Q. alba*). This insect somewhat resembles *C. petiolicola*, and, as I possess only a single specimen of it, the difference indicated in the analytical table may not be a constant one; I will try, therefore, to point out some others. Both species have, between the parapsidal grooves, two lines or grooves running from the collare a short distance backwards; in *C. petiolicola* they are much more distinct, but can hardly be called grooves, as they are smooth lines, easily perceptible, on account of their lustre, among the sculpture of the surface of the mesonotum; in *C. fusiformis* they appear more like furrows, but not being very deep, they have less lustre than those of the other species, and are therefore less perceptible; a third, intermediate, impressed line is, in a certain light, perceptible between them. The scutellum of *C. petiolicola* is more deeply wrinkled than that of *C. fusiformis*. Both species have a short, sparse, microscopic pubescence on the sides of the mesonotum and on the scutellum, but this pubescence is more distinct in *C. petiolicola*. (Compare also below, No. 56, about the possible relationship between this gall and that of *Figites chinquapin* Fitch).

9. C. FUTILIS O. S. (☿; *Q. alba*). 10. C. PAPILLATA O. S., (☿; *Q. prinus*) Proc. etc. I, p. 63–64, Nos. 13, 14. Compare also Bassett, l. c. II, p. 329. These are probably the same species, attacking two different oaks and producing somewhat different galls.

11. C. FLOCCI Walsh ♀, Proc. etc. II, p. 482 (♀; *Q. alba?*). This species, which I have not seen, may possibly belong to *Andricus* Hartig. Whether the gall is identical with the gall *Q. lana* Fitch is not certain. (Compare below, No. 45.)

12. C. PEZOMACHOIDES O. S., Proc. etc. I, p. 250 (♀; *Q. alba?*). Although, at the time I described this insect, I was somewhat uncertain about the kind of oak to which the galls belonged, I hardly doubt now that this insect is the author of the gall called *Q. pisum* by Fitch (Rep. II, No. 319), the *Cynips q. pisum* Fitch being a guest-gall-fly. The gall described by Mr. Walsh as *Q. erinacei* (*Q. alba*; gall-fly unknown) Proc. etc. II, p. 483, may be the same species, as Dr. Fitch also mentions prickles, occasionally occurring on his galls of *Q. pisum*. A difference somewhat more difficult to reconcile is, that Mr. Walsh's gall is said to occur twice as often on the *upper side* of the leaf as on the under side; whereas both Dr. Fitch and myself found the gall *Q. pisum* (which is now to be called *pezomachoides*) always on the

under side. This species probably belongs to the genus *Teras* Hartig, now united to *Andricus.* (Compare also the following species).

13. C. FORTICORNIS Walsh, Proc. etc. II, p. 490 (♀; *Q. alba*), is easily distinguished from the preceding species by its smaller size, the more uniformly reddish coloring of the head and the thorax, and especially by the structure of the antennæ, which are shorter and stouter, whereas they are slender and filiform in the other species. The third antennal joint of *C. forticornis* is not longer than the two preceding taken together, obconical; the fourth is much shorter and also somewhat obconical, and all the following joints, except the last, are almost as broad as long. The third joint of *C. pezomachoides* is about once and a half the length of the two preceding taken together, linear, slender; the fourth, although shorter, has the same linear shape; the following joints (5, 6, 7) gradually diminish in length, but are all elongated. This is also a *Teras* Hartig, and not *Biorhiza* Westw.

14. C. HIRTA Bassett, Proc. etc. III, p. 688 (♀; *Q. montana*); is easily distinguished from the two preceding species by its large size, its uniformly brown coloring and its pubescent abdomen. The structure of its antennæ is like that of the antennæ of *C. pezomachoides* O. S. ~~(Compare also No. 43, below.)~~

15. PHILONIX FULVICOLLIS Fitch, Rep. II, No. 291; 16. PHILONIX NIGRICOLLIS Fitch, Rep. II, No. 292, which the author found on snow in winter, but did not breed from galls, probably belong to *Teras* Hartig. Whether 17. BIORHIZA NIGRA Fitch, Rep. II. No. 290, is really a *Biorhiza*, seems uncertain, but it is not improbable, as the European species of this genus likewise occurs on snow.

18. C. IRREGULARIS O. S., Proc. etc. I, p. 65 (♂; *Q. obtusiloba*); 19. C. MAJALIS Bassett, Proc. etc. III, p. 683 (♂ ♀; *Q. alba*). Both galls are exactly alike, as I have ascertained by comparison, only my description applies to dry galls, Mr. Bassett's to fresh ones. Whether the gall-flies have to be considered as distinct species or as phytophagic varieties, I am uncertain, as I have never possessed more than a single specimen (without abdomen) of *C. irregularis.* By all means this resemblance is close enough to render the description of *C. majalis* useful to consult for the identification of my species, the abdomen of which, as well as the female sex, have not been described by me. I have already discussed above (p. 340) the generic location of these species.

20. C. BATATUS Fitch, Rep. II, No. 311; Bassett, Proc. etc III, p. 684 (♂ ♀; *Q. alba*); (about the generic location compare page 340, No. 4). Having received the gall and the fly from Mr. Bassett, I found, upon comparison, that the gall is identical with the one I took for that

of *C. tuber* Fitch (compare Proc. etc. I, p. 71, No. 27). Mr. Bassett may be right, and if I have any hesitation in this matter, it is on account of the hard, seed-like bodies, mentioned by Fitch as belonging to the gall *Q. tuber*, and not mentioned in the description of the gall *Q. batatus*. These seed-like bodies are *not* to be found in the gall called *Q. tuber* by Mr. Bassett (now *clavula* Bassett). Whether the fly *C. batatus* Bassett is identical with *C. batatus* Fitch is also not quite certain, as Dr. Fitch's short description may just as well apply to a guest-fly (*Ceroptres*) usually obtained in abundance from the same gall. Still, as there is nothing in Dr. Fitch's description to contradict the synonymy, there is no harm in adopting it.

21. C. verrucarum O. S., Proc. etc. I, 62 (♀; *Q. obtusiloba.*) Compare also above, page 340, No. 4. At the time when I described this species I was not positive about the sex of my specimens. I perceive now that they are really females.

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b. Galls on the group of the red, black and willow-oaks.

22. C. spongifica O. S., (♂ ♀; *Q. tinctoria*). 23. C. coccineæ O. S., Proc. I, p. 243–245 (♀; *Q. coccinea.*) Mr. Walsh suggests (Proc. etc. II, p. 445) that as *Q. coccinea* is probably nothing but a variety of *Q. tinctoria*, these two galls, which show but little difference and produce apparently the same insect, may be considered as identical. It may really be so, but the apparent identity of the insect alone would not be a sufficient proof, as it seems that in the group of *Cynipidæ* to which *C. spongifica* belongs, the species are sometimes very difficult to distinguish. (Compare the two following species.) *C. aciculata* O. S. (Proc. etc. I, 56) being the dimorphous ♀ of *C. spongifica*, all that has been said by me (Proc. etc. I, p. 244–245) about the assumed difference between their galls will have to be cancelled. Still, it would be worth while to investigate whether these galls are absolutely identical, so that no outward sign whatever indicates the contents of the gall. *C. confluens* Harris, Ins. etc. p. 546, 3d edit. is apparently synonymous with *C. aciculata*, although Harris says that it occurs on the *red oak*.

24. C. inanis O. S., Proc. etc. I, p. 242 (♂ ♀; *Q. rubra*). Compare also Walsh, Proc. etc. II, pp. 457, 458. At the time when I described this gall, I was uncertain whether it occurred on *Q. rubra* or *Q. coccinea*. Mr. Walsh found it on *Q. rubra* in the environs of Rock Island; and Dr. Fitch, (Rep. II, No. 317) who described this gall as that of *Callaspidia confluenta* Harris, likewise found it on the red oak. Thus the question may be considered as settled. Mr. Walsh was the first to obtain the male sex of this species. I am not aware of any dis-

tinctive character between *C. inanis* and *C. spongifica;* the galls, however, are very different. It is not impossible that we have here not a species, but a phytophagic variety, habitually attacking a different species of oak, and, owing to the physiologic peculiarities of this species of tree, producing a somewhut different gall. *C. futilis* and *C. papillata* (compare above, Nos. 9 and 10) stand probably in the same relation to each other.

25. C. COELEBS O. S., Proc. etc. I, p. 60, No. 7 (♂; *Q. rubra*). The male (the only sex I know), is remarkably like *C. spongifica* ♂, and differs only by its smaller size, its somewhat paler feet, and a less distinct areolet. The gall is very different in shape from the galls *C. spongifica* and *C. inanis*, although the principle of its structure is the same, as it contains a single nucleus, kept in position by fibres radiating towards the shell. If this gall really occurs on *Q. rubra*, of which I have but little doubt, it is a remarkable fact that two insects so closely allied as *C. inanis* and *C. coelebs* should produce so different galls on the same kind of oak. The females (both sexual and dimorphous) of *C. coelebs* remain as yet to be discovered.

26. C. ILICIFOLIÆ Bassett, Proc. etc. III, p. 682 (♂ ♀; *Q. ilicifolia*). The gall is spindle-shaped, like the preceding, but much larger and broader in the middle.

27. C. SINGULARIS Bassett, Proc. etc. II, p. 326 (♂ ♀; *Q. rubra*). Compare also Walsh, l. c. p. 484. Whether *C. nubilipennis* Harris (Ins. etc. p. 548, 3d edit.) is really this insect, seems very doubtful, as I do not perceive in my specimens any vestige of a "smoky cloud on the tip of its wings," which determined the choice of the name of the species. Nor do I think that the description "galls of the size and color of grapes" applies to the gall of *C. nubilipennis* better than to any other gall. The gall described by Dr. Fitch as that of *C. nubilipennis* is certainly identical with Mr. Bassett's gall, but whether it is identical with Mr. Harris' gall, is another question; it is equally uncertain whether the gall-fly which Dr. Fitch calls *C. nubilipennis*, really belongs to his gall, as, according to his own statement, it was found on the ground among fallen oak-leaves. Under such circumstances, I would propose to retain Mr. Bassett's name for the gall and fly described by him.

28. C. OSTEN SACKENII Bassett, Proc. etc. II, p. 327 (♂ ♀; *Q. ilicifolia*). As Mr. Bassett observes, this gall is very like a gall on *Q. coccinea*, which I described (Proc. etc. I, p. 256). Nevertheless, I would hesitate to unite them before convincing myself of the identity of the gall-flies. I do not know the gall-fly of my gall; the gall and gall-fly of *O. Sackenii* I owe to the liberality of Mr. Bassett.

29. C. FORMOSA Bassett, Proc. etc. III, p. 679 (♀; *Q. rubra*). Is not this remarkable species, obtained from the gall in winter, a dimorphous female of some as yet unknown ♂ and ♀ escaping from the gall in summer? I have already made this suggestion above, page 341.

30. C. SCULPTA Bassett, Proc. etc. II, p. 324 (♂ ♀; *Q. rubra*). I have not seen this insect, nor its gall. May this not be the *C. nubilipennis* Harris? (compare above, No. 27). Mr. Walsh has observed on *Q. tinctoria* a gall which he considers as identical with that of *C. sculpta* (Proc. etc. III, p. 639).

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31. C. Q. PHELLOS O. S., Proc. etc. I, p. 70, No. 23 (♀; *Q. phellos*).

32. C. SIMILIS Bassett, Proc. etc. III, p. 685 (♂ ♀; *Q. ilicifolia*). This gall-fly is very like the preceding, and it would require a larger number of specimens than I possess in order to discover permanent differences. *C. similis* is somewhat larger, its abdomen is apparently broader, its coloring somewhat darker, etc. Their galls, judging by Mr. Bassett's description of that of *C. simllis*, are also very much alike.

33. C. Q. NIGRÆ O. S., Proc. etc. I, p. 66, No. 17 (♂ ♀; *Q. nigra*). The gall resembles that of *C. tumifica* O. S.; the gall-fly is easily distinguished by its coloring.

34. C. TUMIFICA, n. sp. (♂ ♀; *Q. tinctoria*). Obtained by me from a swelling on the midrib of the leaves of *Q. tinctoria*. Most of the swellings were near the basis of the leaf; some of them even on the leaf-stalk. Cut open, they show numerous seed-like bodies, arranged in rows, and each containing an insect.

C. tumifica n. sp. ♂ ♀.

♀ 0.09 long. Head brownish-red or yellowish-brown; a blackish spot on the vertex encloses the ocelli; antennæ 14-jointed, the last joint is much shorter than the two preceding joints taken together; their color is yellowish-brown, the last five or six joints are brown. Mesonotum brown, mixed with reddish in such a way that the parapsidal grooves are on reddish ground; a space adjoining the scutellum is also reddish; the surface of the mesonotum is finely, densely, but irregularly rugose and opaque; between the parapsidal grooves two narrow, polished lines run from the collare a short distance backwards; scutellum brown, deeply rugose, and therefore opaque; abdomen dark brown, almost black, polished, with a microscopic punctation on the margin of the segments; sheath of the ovipositor not reaching above the dorsal line of the abdomen; feet brownish-yellow; femora and tibiæ more or less infuscated; the posterior ones more than the foremost ones; tarsi brownish-yellow, brown at tip. Wings hyaline; *no areolet;* stout veins brown.

A single female specimen, bred from galls found in June, near Dobb's Ferry, New York, on *Q. tinctoria*.

Mr. Bassett having found the same gall on *Q. tinctoria* and a similar one on *Q. rubra*, communicated me the flies bred from one of them, he

was not quite sure which. These gall-flies altogether resemble *C. tumifica*, and I do not doubt of their identity. Some of the specimens had the whole mesonotum reddish, and only a broad stripe in the middle, not reaching the scutellum, brown. As among these specimens there were several males, I give here their description.

♂ 0.06—0.07 long; altogether black, except the antennæ, which are brownish, and the feet, which are like those of the ♀; antennæ 15-jointed; third joint elongated, curved; sculpture of the mesonotum exceedingly fine, almost imperceptible, and for this reason the mesonotum moderately shining; the two smooth lines between the parapsidal grooves are perceptible; abdomen very small in comparison to the body; wings like those of the ♀; veins dark brown.

C. modesta and *C. tumifica* are very closely allied and their galls also; both differ principally in size. The insects differ, moreover, by the number of joints of the ♀ antennæ, by the coloring of the latter, which is a uniform brownish-yellow in *C. modesta*, whereas the antennæ of *tumifica* are brown at the tip; by the coloring of the mesonotum of the female, which is uniform brown in *C. modesta* and is more or less mixed with reddish in *C. tumifica*. These two species, with *C. q. nigræ* form a distinct group, having the structure of their galls, the absence of an areolet, the sculpture and coloring, etc. in common, and it is probable that the ♂ of *C. modesta* is, like that of the two other species, distinguished by its small size and dark coloring. It is also worthy of notice that the ovipositor of *C. nigræ* and especially of *C. tumifica* is very often entirely exserted from the sheath, in the shape of a large, free spiral, outside of the abdomen. I do not know how to explain this peculiarity, which I have not observed so constantly in any other species.

35. C. MODESTA O. S. Proc. etc. I, p. 65, No. 16. (♀. *Q. rubra.*) Compare the preceding species.

36. C. OPERATOR O. S. Proc., etc., I, p. 256. (♂ ♀; *Q. nigra.*) Compare also Bassett, l. c. II, p. 332. This species has 12-jointed ♀ antennæ; the length and structure of the sheath of the ovipositor, the structure of the abdomen and the neuration of the wings will probably entitle *C. operator* to become, at once, the type of a new genus. The peculiar character of the neuration (absence of the branch of the subcostal, running towards the margin of the wing) it has in common with *C. similis* and *C. quercus phellos.* Mr. Bassett has observed galls similar to those of *C. operator* O. S. (Q. nigra), on *Q. ilicifolia* and *Q. palustris.* He communicated to me the insects obtained from these galls, and I cannot discover any important difference, except that the hind tibiæ of the specimens obtained from *Q. ilicifolia* were not infuscated, and the subcostal as well as the transverse veins, were somewhat darker.

37. C. VENTRICOSA Bassett, Proc., etc., III, p. 681. (♀. *Q. ilicifolia.*)

38. C. CORNIGERA O. S. I have described the gall, which I observed in considerable number on *Q. palustris* (Proc., etc., I, p. 251). Since then, I have obtained the gall-fly, and let its description follow. Whether the gall observed by Mr. Bassett on *Q. ilicifolia* (Proc. II, 328) belongs to the same species is very uncertain. I have not seen it.

C. cornigera n. sp. ♀. 0. 11 long. Black; the head comparatively broad, as broad as the thorax; face finely and indistinctly pubescent; irregularly rugose, semi-opaque; a few indistinct striæ converging towards the mouth on both sides; mandibles reddish, their tips black; palpi brownish-yellow; front opaque, vertex with some more lustre, finely, irregularly sculptured; antennæ 14-jointed. yellowish-brown, brown towards the tip; third joint nearly as long as the two preceding taken together; the following joints gradually diminish in length; joints 8 to 13 differ but little in length; the last joint is about once and ahalf the length of the preceding. Humeral parts of the collare coarsely rugose, opaque, in contrast to the comparatively smooth and shining mesonotum; the latter with delicate, dense transverse microscopic rugæ, not much diminishing the lustre of the surface; three moderately distinct impressed lines run from the collare some distance backwards; parapsidal grooves very distinctly marked, but their margins are less well cut or less smooth than usual, as if the groove was formed by a series of confluent punctures; the lateral grooves partake of the same character, and are somewhat curved, with the convexity on the outside; tegulæ yellowish-brown; pleuræ densely and irregularly sculptured, opaque, except a shining spot on their upper portion; scutellum deeply and coarsely rugose; abdomen black, or rather dark-brown, polished, the margins of the segments lighter brown; second segment comparatively large; ventral valve ending in a short apicule, bearing a tuft of hairs; feet brownish-yellow, tips of tarsi brown; hind femora and tibiæ infuscated; middle femora sometimes also. Wings hyaline, somewhat whitish, stout veins pale-brownish; areolet distinct.

I possess only two specimens, bred from the gall; one of them is certainly a female; the abdomen of the other is somewhat injured, and as, at the same time the 14th antennal joint shows an indistinct subdivision in two, it is not impossible that this is a male.

39. C. PUNCTATA Bassett, Proc. etc. II, p. 324. (♀; *Q. rubra.*)
40. C. PODAGRÆ Walsh, Proc. etc. II, p. 492. (♀; *Q. tinctoria.*)
About these species probably being merely phytoghapic varieties, compare Walsh, l. c. in the foot-note. Although more than 120 specimens were reared by both authors, no male has yet been found.*

41. C. SCITULA Bassett, Proc. etc. III, p. 683. (♂ ♀. *Q. tinctoria.*) The difference in the size notwithstanding, there is a striking analogy in shape and sculpture between this species and the former. I have

* I have found nearly 600 specimens—all females.—*H. F. Bassett.*

already commented upon this analogy (page 342). The galls seem likewise to be somewhat alike.

42. C. QUERCUS PALUSTRIS O. S. Proc. etc. I, p. 62, No. 11., l. c. I, p. 251; Walsh, l. c. II, p. 488; Bassett, l. c. II, p. 329. This gall, originally found by me on *Q. palustris*, has been found since on *Q. tinctoria, coccinea, falcata, imbricaria* and *ilicifolia*. The insects from all these galls belong apparently to the same species.

The insects producing the following galls, are as yet unknown and some of them may not belong to the *Cynipidæ* at all.

43. Gall on *Q.* bicolor ~~*prinos*~~, described by me, Proc. etc. I, p. 254. ~~May it not be the same as the gall of *C. hirta* Bassett (*Q. montana*)?~~

44. Gall on *Q. palustris*, described by me, Proc. etc. I, 253. The gall described by Mr. Walsh (Proc. etc. II, p. 481) under the name of *Q. pilula* (*Q. tinctoria*), the gall-fly of which he did not obtain, is not unlike my gall of *Q. palustris*. Mr. Walsh's gall is the produce of a *Cecidomyia;* the orange-colored larvæ, mentioned by this author (l. c. at the bottom of the page) are larvæ of that genus of Diptera; and the gall itself is the same which has been mentioned by me, (in the *Monographs on N. A. Diptera*, Vol. I, p. 201, line 10 from the top,) in connection with *Cecid. symmetrica* O. S. It is not improbable, therefore, as already suggested by me (Proc. etc. I, p. 253), that the gall of *Q. palustris* there described is likewise the produce of a *Cecidomyia*. The fact that Mr. Walsh bred an inquilinous gall-fly, *Ceroptres* (Amblynotus) *inermis* Walsh, from his gall is very remarkable, and I believe the only instance on record of a Cynipidous insect living as guest in a dipterous gall.

This has afterwards proved to be the gall of Cecidomyia.

45. CYNIPS Q. LANA Fitch (*Q. alba*), being probably not a *Cynips*, but a guest-fly, perhaps *Synergus*, the gall-fly of the gall which Dr. Fitch describes under the name of *Q. lana*, is as yet unknown. Mr. Bassett has communicated to me specimens of a gall answering exactly to Dr. Fitch's description and figure. Until the gall-fly of *Q. lana* Fitch (which gall will have to be called then by the name of that gall-fly) is bred, the question of the identity of this gall with that of *C. flocci* Walsh, can hardly be settled. Judging by the measurements given by Mr. Walsh (0.2—0.4), his gall seems to be usually smaller. (Compare Walsh, Proc. etc. II, p. 482.)

46. Gall on *Q. obtusiloba* similar to the preceding, and described by me Proc. etc. I, p. 62. My specimens are of a darker, more brownish-yellow color than the gall *Q. lana* Fitch, and seem usually to occur near the basis of the leaf, whereas *Q. lana* is generally found about the

middle of the leaf. It may be inferred hence, that these galls are the produce of two different insects.

47. These two galls (on *Q. prinus* and *alba*) were mentioned by me, Proc. etc. I, p. 62, in connection with the gall of *C. verrucarum.*

48. Gall on *Q. palustris*, described by me, Proc. etc. I, p. 253.

49. Gall on *Q. obtusiloba*, described by me, Proc. etc. I, p. 255.

50. Gall on *Q. alba*, described by me, Proc. etc. I, p. 255. When dry, these galls become brown and hard like wood; being crowded together, their lower ends become wedge-shaped.

51. Gall on *Q. rubra*, called *Q. decidua* by Mr. Bassett, Proc. etc. III, p. 689; this gall, of which I have specimens, has some analogy to that of *Q. obtusiloba* (No. 46), but it is certainly different.

52. These galls were described by me, Proc. etc. I, p. 256, as being from an unknown kind of oak. Since then, Mr. Bassett communicated to me apparently similar galls, found in Ohio, on *Q. bicolor*. As the specimens described by me were communicated to me by Dr. Morris, together with the gall of *C. strobilana*, occurring on *Q. bicolor*, it is not unlikely that they were found on the same tree.

53. Mr. Walsh mentions this gall in the following manner (Proc. etc. III, p. 639):—"I found last August and early in September, in very great numbers, both on *Q. rubra* and *Q. tinctoria*, growing *from the side of the cup of the acorn*, a globular, smooth, plum-like, fleshy, intensely bitter gall, about 0.50 to 0.75 inch in diameter, mottled with yellowish and crimson outside and internally yellowish in the centre, and towards the circumference pink, like a watermelon. This gall, of which I forwarded a specimen to Baron Osten Sacken, is thought by him to be identical with his *Q. juglans*, which was described only from dry, shrivelled up specimens, and which was stated by Mr. Hitz, who found it, 'to grow on the *branches* of the *White Oak*.' . . . Either Mr. Hitz must be mistaken, . . . or else my gall is a distinct species. If so, I propose for it the name of *Q. prunus*." The dry gall sent by Mr. Walsh looks exactly like the galls which I have described Proc. etc. I, p. 255, under the name of *Q. juglans*. The inside, however, of the dry gall is porous, like pith, and therefore much less hard than that of my galls. The identity of these galls seems therefore at least doubtful, since I have compared them more closely.

54. Although different in shape, this gall, found on *Q. falcata* and described by me Proc. etc. I, p. 69, No. 20, belongs to the same type of structure with the gall *C. spongifica*, and probably produces an insect of the same group.

55. Gall on *Q. prinoides*, called *C. q. frondosa* Bassett. Proc. etc. III, p. 688.

56. Spindle-shaped galls, inserted like pins on the leaves of *Q. prinoides*, described by Dr. Fitch (Rep. II, No. 320). He bred from it an insect which he calls *Figites chinquapin.* The description of the gall answers that of *C. fusiformis* very well; that the insect obtained from it by Dr. Fitch is the real author of the gall is possible, but uncertain. Likewise it does not appear why Dr. Fitch calls this gall-fly a *Figites.*

57. Gall on *Q. alba*, described by Dr. Fitch (Rep. II, No. 319) as that of *C. q. pisum*, which, however, is a guest-fly. I mention this gall-fly at this place, as I am not quite certain whether *C. pezomachoides* O. S. has been bred from a gall on *Q. alba.* (Compare above, No. 12.)

58. Gall on *Q. alba*, described by Mr. Walsh as *C. q. erinacei*, (Proc. etc. II, p. 483) the gall-fly being unknown. About the identity of this gall with the preceding compare above, No. 12.

N. B.—The following galls on the *live oak* (*Q. virens*), described by me in my former papers, have been altogether omitted in the *Synoptical table*, as well as in the *Remarks*, both of which were especially intended for the fauna of the Middle and Northern States:—

I. On leaves.

1. Small globular gall, Proc. etc. I, p. 57.
2. Woolly gall, Proc. etc. I, p. 259.

II. On branches.

3. Clusters of galls not unlike the galls of *C. forticornis* Walsh in appearance, Proc. etc. I, p. 258.
4. Woody swelling of the limb, Proc. etc. I, p. 258.

The gall-flies of all these galls are unknown.

Genus RHODITES.

(Galls on the genus *Rosa.*)

The six N. A. species of this group are sufficiently characterized in the Proc. etc. II, p. 45 and the following.

Genus DIASTROPHUS.

(Galls on the genera *Rubus* and *Potentilla.*)

To the two species described by me, (Proc. etc. II, pp. 36 and 39) and occurring on *Rubus*, Mr. Bassett had added a third, bred from a gall on *Potentilla* (Proc. etc. III, p. 690.) It is somewhat like my *D. nebulosus*, but certainly distinct.

SECTION II.

("Area radialis brevis, lata; areola intermedia." Hartig, l. c. p. 186.)

Of the six genera placed by Hartig in this section, *three—Xystus* (=*Allotria* Westw.), *Cothonaspis* (=*Eucoila* Westw.) and *Megapelmus* (=*Anacharis* Westw.)—have been removed since among the *Figitidæ*. The three remaining genera are defined by Hartig as follows:

a. Abdomen collo lævigato.
  1. Antennæ clavatæ, ♀ 13, ♂ 14 articulatæ.
    Palpi maxill. 5 artic.; palpi lab. 3 art., articulis ultimis appendiculis lateralibus cylindricis..**Ceroptres.**
  2. Antennæ filiformes, ♀ 13–14, ♂ 15–16 articulatæ; flagellum articulis longitudine æqualibus.
    Palpi maxill. 5 artic.; palpi lab. 3 art.; articulis ultimis appendiculis parvis, acutis, coronatis..**Aulax.**
b. Abdomen collo tumido, striolato.
    Palpi maxill. 5 artic.; palpi lab. 2 art.; articulis ultimis appendiculis validis coronatis..**Synergus.**

Since Hartig, only one new genus, apparently belonging to this section, has been described. This is *Phanacis* Fœrster (Verh. d-Rheinl. Vereins für Naturk. XVII, p. 145, 1856). I will translate the definition of this genus, and add an extract from the description of the species.

"**Phanacis** Fœrst. Maxillary palpi 4-, labial palpi 3-jointed; radial area closed; second cubital likewise closed on the inside. Thorax not pubescent, scutellum cushion-shaped; the tip of the metathorax (called *neck* by Hartig) is provided with delicate longitudinal ridges; the first abdominal segment is the largest."

"This genus, belonging to the family *Cynipidæ*, may be next to *Ceroptres* in the structure of its abdomen, but differs from it in several points; such are principally the 4-jointed maxillary palpi and the sharp ridges, with which the apex (neck) of the metathorax is provided. The pleuræ are not aciculate, but finely coriaceous, entirely opaque; the antennæ are almost imperceptibly incrassated towards the tip, not clavate. If, with all this, we take the mode of life into consideration, there will be no doubt left that this is a well established genus."

"*Observation.*—Both pairs of palpi show on the last joint a distinct subuliform point, which has not been counted, however, as a distinct joint."

The species *Phanacis centaureæ* has been reared from the stalks of *Centaurea scabrosa;* only females were obtained. They have 13-jointed antennæ, head and thorax have very little lustre and are finely coriaceous, the mesonotum finely transversely rugose; parapsidal grooves distinct. "The second abdominal segment" (called by Fœrster *the first* in the generic characters given above) "is about equal in length to one-half of the abdomen; the third is much shorter and about equal to all

the following taken together; a short ovipositor protrudes in a straight direction from the tip; the radial area is closed on the anterior margin by a somewhat paler vein, and the small second cubital is not opened internally, but completely closed by a pale-colored prolongation of the cubitus."

It is not quite clear what Fœrster means by the *apex of the metathorax*, called, as he says, *neck* by Hartig. The last named author called *neck* (*collum*. compare the analytical table given above) what we call the *first abdominal segment*, which is narrow, tubular, neck-like, and sometimes (as in the genus *Synergus*) longitudinally striate. The apex of the metathorax is quite a different thing; it is a narrow projection of the metathorax, adapted, by its shape, to be inserted in the neck-like first abdominal segment.

Having communicated to Dr. Reinhard specimens of N. A. *Aulax* (*A. sylvestris*), *Synergus* (*S. lignicola* and *S. campanula*) and *Ceroptres* (two species) and having also obtained from him types of *Aulax* (four species) and *Synergus* (three species), I have attempted to characterize these genera in the sequel. The principal characters may be laid down as follows:

Synergus.—First abdominal segment longitudinally striate; the second occupies, *in both sexes*, the whole remaining surface of the abdomen and conceals all the following segments.

Aulax.—Abdomen of a very different structure in the two sexes; in the male, the second and third segments are subequal in length, and occupy, together, the larger portion of the surface of the abdomen; in the female, the second segment alone occupies nearly the whole surface of the abdomen; first segment exceedingly short, not longitudinally striate; the third and the following more or less concealed under the second.

Ceroptres.—The second abdominal segment occupies, *in both sexes*, the greater portion of the surface of the abdomen; a *delicate, connate suture divides it apparently into two segments.*

Among the unnamed species of my collection I possess one which was communicated to me, in several male and female specimens, by Mr. Bassett. He informed me that they were bred from stalks given to him by some person, who said they were mustard stalks. Mr. Bassett is of the opinion that by all means these stalks must belong to some cruciferous plant. The pith of the stalk contains numerous round cells, in which the insect probably underwent its transformation.

The gall-fly has a closed radial area, the structure of which is nearer to that of the gall-flies of the second section than to that of the first.

The radial area of *Diastrophus* alone, among the first section, would remind of that of the new species, if the latter was not closed. The abdomen of both sexes does not show anything of the great preponderance of the second abdominal segment, characterizing both sexes in *Synergus* and *Ceroptres* and the female sex in *Aulax*. Thus, in more than one respect, this species seems to hold an intermediate position between the two sections of *Cynipidæ*.

We have had occasion to remark, more than once, how important a character the sculpture of the thorax is among the *Cynipidæ*. In many cases this sculpture characterizes the genus. The sculpture of the thorax of our new species is very peculiar; the surface is semi-opaque and has a silky (sericeous) gloss, due to a microscopic coriaceous sculpture on the mesonotum and to exceedingly delicate aciculate striæ on the pleuræ. Judging from Mr. Fœrster's description of *Phanacis centaureæ*, it seems that the sculpture of its thorax is somewhat of the same nature, and a closer comparison of his generic definition leads to the belief that both species must be closely allied. Only the minute ridges on the "apex" of the metathorax, mentioned by Fœrster, do not exist in my species.

Among the species of European *Aulax*, communicated to me by Dr. Reinhard, there is one, *A. hieracii* (Bouché) Hartig, which differs very considerably from the three other species sent by him, (*A. brandtii* Hartig, *germanus* Gir., and *potentillæ* Vill.) Whereas the three latter come within my definition of the genus *Aulax*, the former shows the most remarkable analogy to the new species in question, bred from *Sinapis*. The structure of the abdomen, the sculpture of the thorax, the neuration, etc., are very nearly the same. Now, the so-called *Aulax hieracii* is said not to be a guest gall-fly, but a psenidous gall-fly, living on *Hieracium*. This would establish a new point of relationship between it and the new North American species, as well as with *Phanacis*.

It seems, therefore, that we have here a group of species living on different herbaceous plants and intermediate between the gall-flies of the oak, the rose and the bramble on one side and the guest gall-flies on the other. There is no doubt, that in the course of time, many other species will be added to this group; it may also happen, that most of these species will have to be united in a single genus, or that the definition of *Phanacis*, somewhat modified, will apply to a number or to all of them. Our data are too scanty to warrant, as yet, any conclusion, but we recommend the subject to the attention of observers

and wish that, in the meantime, Mr. Bassett would describe the new species.*

Leaving aside, for the present, this intermediate and as yet doubtful group, the following question requires, at this point, our attention. Are all the *Cynipidæ* of the second section of Hartig guest gall-flies or not? All the American gall-flies of the genera *Synergus*, *Ceroptres* and *Aulax*, which I have had the opportunity to observe, are guest gall-flies. But Hartig and Giraud mention a number of *Aulax*, which they considered at true *Psenides*. This may really be the case, but before admitting it, we must advert to two circumstances, which may be sources of error: 1. We have seen that *Aulax Hieracii*, which is one of the species said to be *psenidous*, is generically distinct from the other species of *Aulax;* Dr. Reinhard writes me that *A. glechomæ* Htg., another *psenidous Aulax* "will probably have to be removed to the genus *Diastrophus;*" this proves, that the definition of *Aulax* by European authors is more loose than that which we have adopted; may not all the gall-producing *Aulax* of Hartig and Giraud belong to other genera? 2. We have had frequent instances of *inquilinous* gall-flies erroneously taken for the originators of the galls, and why could not the same error have taken place with regard to certain species of *Aulax?* I possess, for instance, the European *A. potentillæ* Villers, which is a true *Aulax*. As the name implies, it is probably reared from a gall on *Potentilla*. (I have not been able to compare the original reference.) Now, Mr. Bassett has recently described a *Diastrophus* producing a gall on *Potentilla*. *Aulax*, as we know, is frequently a guest of *Rhodites* and *Diastrophus;* is it not possible that *A. potentillæ* is likewise the guest of a *Diastrophus?* I am far from affirming that such is the case; my purpose is merely to show how an error of this kind may originate. The question whether *Aulax* is an entirely *inquilinous* genus, thus remains as yet open.

Genus AULAX.

Abdomen (♂), with the segments 2 and 3 subequal in length, the following somewhat projecting beyond the third; in the ♀ the second segment occupies nearly the whole surface of the abdomen and more or less conceals the following segments. Antennæ 14-jointed (♂), and 12- (sometimes 13?) jointed (♀).

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* Mr. Walsh has communicated me a gall-fly, which I cannot distinguish from Mr. Bassett's gall-fly of *Sinapis*, and which he bred from "a woody subspherical gall, surrounding a twig of *Q. rubra*." I merely state the fact, leaving it for future observers to reconcile it with M. Bassett's statement.

The female of *Aulax* resembles that of *Synergus* in the structure of the abdomen; it differs, however, in the extreme shortness of the first abdominal segment, *which is not striated*, and probably also by the number of antennal joints, which, in both species known to me, is 12 and not 13. From the ♀ of *Ceroptres*, it is distinguished by the absence of any suture on the second segment.

The ♂ of *Aulax* is easily distinguished from the ♂ of *Synergus* by the structure of the abdomen; it differs from that of *Ceroptres* by the subdivision of the second segment into two parts, not merely by a *connate suture*, but by a real incisure.

In the general remarks about the second section of *Cynipidæ*, I have discussed the question whether this genus is entirely inquilinous or not. The question is still a doubtful one. The European *A. Brandtii* Hartig, *caninæ* Hartig, *germanus* Gir. and the American *A. pirata* O. S., and the doubtful *A. semipiceus* Harris, are guest gall-flies in galls of the genus *Rhodites*. *A. sylvestris* O. S. occurs in the galls of *Diastrophus*. *Aulax pumilus* Gir. have been bred from an oak-gall of *Andricus*. As *psenidous* species of *Aulax* have been considered :— *A. hieracii* Htg., which I possess and which is no *Aulax* at all, *A. glechomæ* Htg., which, according to Dr. Reinhard's statement, is probably a *Diastrophus*, *A. Rhœadis* Htg., *A. minor* Htg. (both on *Papaver*), *A. sabaudi* (on *Hieracium*), *A. salviæ* (on *Salvia*), *A. scorzoneræ* (on *Scorzonera*). The five last species I do not know and am not able to confirm whether they really belong to *Aulax* or not. (About *A. potentillæ* I have not been able to compare the reference.)

The described N. A. species are the following:

1. Aulax sylvestris O. S. Proc. Ent. Soc. Philad. II, p. 37. Bred from the gall of *Diastrophus nebulosus*, on the blackberry.

2. I possess a specimen very like the preceding species, only smaller and showing but slight differences, which was bred from the gall of *Rhodites radicum*. I have explained already (Proc. etc. II, p. 42, 4) why *Cynips semipicea* Harris (Ins. etc. p. 549), can hardly be synonymous with my *Rhodites radicum*. It is not at all improbable that Harris reared the above mentioned *Aulax* from the gall and mistook it for the gall-producer. This would then be *Aulax semipiceus* Harris. Whether it is synonymous with *A. sylvestris* I do not attempt to decide, having only a single specimen for comparison.

3. Aulax pirata O. S., l. c. p. 42. Bred from a rose-gall.

4. Aulax? futilis O. S., l. c. I, p. 64. This species is doubtful, as I was not acquainted with the characters of the genus *Aulax* at that

time and have accidentally lost, since then, the only specimen which I had reared from the gall of *C. q. futilis* O. S.

Genus CEROPTRES.

This genus is easily distinguished by an impressed, transverse line, dividing the second abdominal segment into two portions, which are subequal in length in the male, and the anterior of which is much shorter than the posterior in the female. A very close attention is often required in order to perceive this line, which otherwise seems to be a good distinctive character. Whether this line really represents a *connate suture* I am unable to say, as the decision of this point would require a dissection which I cannot now undertake.

Although the second segment (considered as a whole, as if the suture did not exist) is very large in comparison with the others, it does not, as is the case with *Synergus*, entirely conceal all the following segments; these project more or less considerably beyond the posterior edge of the second segment, so that the segments three to seven can be easily counted in some specimens; in others, however, they are more contracted. The first abdominal segment is very short, projecting only a little, in the shape of a rim, over the anterior edge of the second segment, and not at all tubular and striated, as in *Synergus*. Another important difference from the latter genus consists in the length of the sheaths of the ovipositor, which project very considerably above the dorsal line. *Ceroptres pisum* O. S. is the only species having, apparently, very short sheaths; but I am not certain whether they are really so, or only broken off in the only specimen of that species which I possess. The basal portion of the second abdominal segment is usually more or less downy. The polished surface of the pleuræ is perfectly smooth and shining in all the specimens in my possession, or aciculate on its lower part only, whereas it is more or less aciculate in all the species of *Synergus* which I have seen. As Hartig, however, places *Ceroptres* among the genera with *aciculate pleuræ*, as may be seen on the analytical table of page 362, this character is probably not one of general application. The antennæ are 15-jointed in the male and usually 12-jointed in the female; the last joint in the female is very elongated, fully equal to the two preceding joints taken together; occasionally this joint is subdivided in two joints by a distinct suture, and then the antennæ are apparently 13-jointed. *Ceroptres pisum* has 13-jointed antennæ and the last joint is subdivided into two joints. Hartig calls the antennæ 14- (♂) and 13- (♀) jointed. In some of the species the antennæ are very slightly incrassated on their latter half; in others this character is not perceptible. I think that Hartig gives

it too much importance when he says (Germ. Zeitschr. III, p. 343) that it distinguishes the genus.

Misled by the impressed line on the second abdominal segment. which is not mentioned anywhere in Hartig, I had previously considered this genus as belenging to the *Figitidæ* (Proc. Ent. Soc. I, p. 67) and had doubtingly referred it to *Amblynotus* Hart. I owe the correction of my error to Dr. Reinhard, to whom I communicated two species; a small one, reared from the gall of *C. q. verrucarum*, which has slightly incrassated (sub-clavate) antennæ, and a larger one, reared from the gall of *C. q. batatus* Fitch, with filiform antennæ. The first was returned as *Ceroptres;* the second was sent back by *Dr. Reinhard* with the following remark: "This species may also be taken for *Ceroptres;* the structure of the abdomen is exactly the same, only the pubescence at the basis is stronger than usual; a more striking difference is that the antennæ are filiform; this might render the generic identity doubtful." It would be hardly prudent, however, to establish a new genus on such slight differences; the better plan will be to keep the structure of the second abdominal segment in view as the principal character of *Ceroptres.*

I have mentioned the communication of Dr. Reinhard to me about *Ceroptres* in order to prove that, the discrepancy between Hartig's characters and my specimens notwithstanding, these specimens really belong to *Ceroptres.*

The species of this genus are very difficult to distinguish on account of the great uniformity of the coloring of the body and the apparent inconstancy in their size and the coloring of their feet. The differences in the sculpture of the thorax, which would afford the principal characters for specific distinction, seem to be very slight here, and for this reason are difficult to describe. I leave, therefore, the task of describing the species to those who will be in possession of more materials, principally obtained by breeding large numbers of specimens from different galls. My present object is merely to point out those among the described N. A. *Cynipidæ* which, according to my opinion, belong to *Ceroptres*, but in doing so I do not even pretend to decide whether all these species are really distinct, or whether some of them would not be better united.

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1. **Ceroptres ficus** Fitch.

Syn. *Cynips q. ficus* Fitch, Rep. etc. II, No. 314.

Synophrus læviventris Walsh, Proc. Ent. Soc. Phil. II, p. 494. (*Exparte.*)

Mr. Walsh, probably deceived by the coloring of this species, which

he had obtained from the gall of *C. forticornis* (called *C. q. ficus* by Fitch), took it to be identical with the specimens of *Synergus læviventris*, which he bred from the gall of *C. spongifica*. But I agree with this author in thinking that the specimens which he bred from the gall of *C. forticornis* are the *Cynips q. ficus* of Fitch, the latter author having in this case, as in several others, mistaken the guest-gall-fly for the gall-producer. This insect has, in accordance with Dr. Fitch's statements, 13-jointed ♀ antennæ, the hind tibiæ dusky, the head partly yellowish or reddish, etc.

2. **Ceroptres petiolicola** O. S. ♂ ♀.

Syn. *Amblynotus? petiolicola* O. S. Proc. Ent. Soc. Phil. I, p. 67.
Amblynotus ensiger Walsh (?), Proc. etc. II, p. 496.

Bred from the gall of *C. petiolicola* Bassett. Since the above mentioned description of mine, which was based on one or two specimens only, I have reared two more specimens from the same gall, a ♂ and a ♀. The male has the middle and hind femora and tibiæ dusky, and a black line on the upper side of the fore-femora. The ♀ has apparently 13-jointed antennæ and infuscated femora. These differences from *Ceroptres* (Amblynotus) *ensiger* Walsh (Proc. Ent. Soc. II, p. 496), notwithstanding, I incline to believe, with Mr. Walsh, that his species is identical with mine. The twelfth antennal joint of the ♀ (which is the last, according to Mr. Walsh's opinion,) may, in some specimens, show a more distinct suture and be counted for two joints. As to the difference in size and in the coloring of the feet, they seem to be very variable, as we will see, for instance, in the species reared from the gall of *Cynips q. batatus*.

3. **Ceroptres inermis** Walsh.

Syn. *Amblynotus inermis* Walsh, Proc. etc. II, p. 498.

Reared from the same author's gall *Q. pilulæ*, and unknown to me. This gall being that of a *Cecidomyia* and not of a *Cynips*, it is a remarkable and heretofore unique instance of a guest-fly inhabiting the gall of a dipterous insect. The differences between *C. inermis* and *C. ensiger* are explained by the author, l. c.

4. **Ceroptres pisum** O. S.

Syn. *Sarothrus? pisum* O. S., Proc. etc. I, p. 59.

In my description I have erroneously stated that my specimen is a male and that it has 14-jointed antennæ; and in this case again, deceived by the transverse line dividing the second segment, I was induced to think that this insect belongs to the *Figitidæ*. That *Cynips q. pisum* Fitch is not the gall-fly of the gall described by Dr. Fitch, Rep. II, No. 319, but a guest-fly, seems certain, since the discovery of *C. pezomachoides* O. S.

(unless it is proved that I was mistaken in the supposed identity of *Q. pisum* with the gall which gave me the latter species; compare above, p. 352, No. 12). But whether this guest-fly is identical with *Ceroptres pisum* O. S. is rather doubtful, as my specimen measures 0.14, whereas Dr. Fitch's species is said to be 0.08 (♂) and 0.11 (♀) long.

In order to complete my previous description, I give a new one here:

♀. About 0.14 long; head black, finely pubescent; mandibles and the mouth brownish red: face aciculate, an oblong swelling under the antennæ; vertex microscopically punctate: antennæ brownish-yellow, 13-jointed, nearly as long as the body, almost filiform; fourth joint slightly longer than the third; the following joints very gradually diminish in length; the thirteenth or last joint is twice the length of the preceding; a distinct suture divides it in two parts, in the only specimen in my possession. Thorax black, finely pubescent and densely, but very delicately rugose: parapsidal grooves distinct, moderately deep; between these grooves two very indistinctly marked impressed lines run some distance from the collare backwards; scutellum with a deep, rough, irregular sculpture; polished space on the pleuræ smooth. Abdomen dark brown or black, paler brown along its inferior edge: second joint divided into two unequal parts by a very distinct suture; the first part has, dorsally, a little less than half the length of the second; at the basis of this second segment the abdomen is distinctly downy; the ventral valve is pale brown, considerably projecting, its tip at an angle of somewhat more than 45°; the sheaths of the ovipositor do not project at all above the dorsal line. The feet are yellow, except the extreme basis of the coxæ, especially of the hind ones, which is black, and the tip of the tarsi, which is infuscated. Veins of the wings pale yellow; areolet of moderate size, its posterior portion somewhat indistinct.

Bred a single specimen from the gall called *Q. pisum* by Dr. Fitch, but which is probably the produce of *Andricus* (Teras) *pezomachoides* O. S. This species is larger and more slender than the other species of the genus. It is remarkable for the contrast between the sculpture of the scutellum, which is very deeply rugose, and that of the thorax, which is very delicate and perceptible only under a strong lens. Whether the shortness of the sheath of the ovipositor is really a character of the species, or whether its tip is broken off in the only specimen which I possess, I am unable positively to affirm; in the first case, this character would distinguish this species from the other known species of the genus.

5. **Ceroptres arbos** Fitch.
Syn. *Cynips q. arbos* Fitch, Rep. II, No. 310.

6. **Ceroptres tuber** Fitch. (?)
Syn. *Cynips q. tuber* Fitch, Rep. II, No. 309.

Mr. Bassett has shown (Proc. etc. III, p. 687) that both galls, described by Dr. Fitch under the above-mentioned names are produced by the same gall-fly, which was not known to Dr. Fitch, and that this

gall-fly occurs only on soft, green shoots of the same year's growth, whereas the galls of the last year's growth, the only ones described by Dr. Fitch, always give guest-flies. These guest-flies, as I have had occasion to observe myself, belong to the genus *Ceroptres*. We can take it for certain, therefore, that *Cynips q. arbos* Fitch, the male of which is said to have 15-jointed antennæ, is a *Ceroptres*. Whether *C. q. tuber* Fitch, belongs to the same genus, is somewhat doubtful, as it is said to have 14-(♂) and 12-(♀) jointed antennæ. Whether this statement is based upon a mistake, or whether *Ceroptres* ♂ sometimes has 14-jointed antennæ (which would agree with Hartig's statement), or, finally, whether *C. q. tuber* Fitch, belongs to some other inquilinous genus, I do not pretend to decide. The last hypothesis, however, seems to me the most improbable of all.

7. I have bred numerous ♂ and ♀ specimens of *Ceroptres* from the gall of *C. q. batatus* Fitch (the same gall which I erroneously took, Proc. etc. I, 71, 27, for that of *C. q. tuber* Fitch). These specimens were mentioned by me (l. c.) as belonging to *Amblynotus*. They vary very much in size and in the coloring of the feet, which are more or less infuscated; some specimens have the hind femora and tibiæ almost black. Most specimens have the cheeks reddish, which distinguish them from my specimens of *C. petiolicola* and of *C. arbos* with which they otherwise closely agree. The tip of the ventral valve forms, usually, an angle of 45°, sometimes a little larger; the ♀ antennæ are 12-jointed. I leave it undecided whether all the specimens showing the above differences belong to the same species, and whether this species is only a phytophagic variety or race of *C. petiolicola* and *C. arbos*.

8. Besides the above-mentioned doubtful species, I possess several specimens of the same genus, but which certainly belong to a distinct species. Without naming or describing this species, I will, by a short notice, draw the attention of observers to it. I have bred these specimens from the gall of *Cynips verrucarum* O. S. (*Q. obtusiloba*). They are hardly 0.5 long, black, with yellow feet; parapsidal grooves not apparent, except near the scutellum; surface of the thorax smooth, with an exceedingly fine, hardly apparent pubescence; viewed from above, the thoracic dorsum seems to be slightly flattened. The antennæ (♀) are 12-jointed and somewhat incrassated towards the tip. This is the species which Dr. Reinhard returned to me as the true representative of *Ceroptres* Hartig.

Genus SYNERGUS.

The structure of the abdomen affords the characteristic marks of this

genus; the first segment is longitudinally striate; the second conceals all the following in both sexes. The antennæ are 15-jointed (♂) and 13 or 14-jointed (♀). The seven known North American species have the polished spot on the pleuræ aciculate; in *S. mendax* this sculpture, although very faint, also exists. The species of *Ceroptres* known to me, have these spots perfectly smooth; this difference between the two genera may however not prevail through all the species, as Hartig places *Ceroptres* among the species with aciculate pleuræ. The sheath of the ovipositor is much less projecting above the ventral line in this genus than in *Ceroptres*.

The first segment of the abdomen usually appears somewhat tumid, as was already noticed by Hartig (*abdomen collo striato, tumido*, says he); but it seems to me that this appearance is merely an optical illusion, produced by the presence of the striæ. The face is aciculate, the striæ converging towards the mouth; but as this character seems common to all the species, and in fact, to a great many *Cynipidæ*, it has been omitted in the descriptions.

The species of *Synergus* are very numerous in Europe and rather difficult to distinguish, being not only very uniform, but also very variable, in their coloring; it has been observed, however, that in the species of mixed coloring (black and yellow), certain parts of the body only are subject to variations, others preserving, on the contrary, a very constant coloring. The principal characters have to be derived from the shape of the body, especially of the abdomen, and from the sculpture of the thorax. Hartig also adverts to frontal ridges immediately above the eyes, which, in some species, reach the vertex, in others run only a very short distance. I distinctly perceive very short ridges of this kind in *S. oneratus* and *S. campanula*, but characters of such extreme delicacy are apt to mislead, as their perception is too dependent on optical conditions.

The following arrangement of the seven known North American species applies principally to females, the males of some of the species not being yet discovered *Cynips quercus lana* Fitch, Rep. II, No. 316, apparently likewise a *Synergus*, but unknown to me, has not been included in this table.

1. Prevailing color of the body yellow 2
   Prevailing color of the body black 3

2. Antennal joints 3 and 4 of nearly equal length; mesonotum reddish-yellow, with a more or less broad, sometimes obsolete black stripe in the middle; antennæ (♀) 14-jointed. } 1. **S. oneratus** Harris ♀.

Antennal joint 4 but little more than half the length of the third; antennæ (♀) 13-jointed; mesonotum entirely black, the yellow being strictly confined to the collare. } 2. **S lignicola** O. S. ☿ ♀.

3. Mesonotum with coarse, transverse, ridge-like rugosities, giving it a rough appearance.. 4

Mesonotum with fine transverse wrinkles, preserving, however, a smooth appearance.. 5

4. All the feet partly infuscated; antennæ (♀) 14-jointed, nearly as long as the body; the second abdominal segment seen from the side is distinctly longer than broad. } 7. **S. mendax** Walsh ♀.

The hind tibiæ and the basis of the hind tarsi alone are infuscated; antennæ (♀) 13-jointed; the second abdominal segment, (♀) seen from the side, is but very little longer than broad; thorax of ♀ black; in the ☿ the pleuræ and the head are yellow. } 5. **S. dimorphus** O. S. ☿ ♀

5. Second abdominal segment, (♀) seen from the side, much longer than broad, attenuated to a point at the tip, almost lanceolate. } 3. **S. læviventris** O. S. ♀.

Second abdominal segment (♀), seen from the side, but little, or not longer than broad.. 6

6. Long (♀), ventral valve considerably projecting..6. **S. albipes** Walsh, ☿ ♀.

Long (♀), ventral valve usually concealed......4. **S. campanula** O. S. ♀.

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1. **Synergus oneratus** Harris.

Syn. *Cynips oneratus* Harris, Ins. etc. 3d ed. p. 548. Fitch, Rep. etc. II, No. 313.

This species (0.12—0.14 long) is variable in coloring, the black stripe in the middle of the thorax and of the head having more or less extent; in some specimens the head has no black spot at all, and the stripe on the thorax is also obsolete. It is distinguished from the following species: 1st, by its larger size; 2d, by the antennæ of the ♀ being 14-jointed. If extended backwards, they would almost reach the tip of the second abdominal segment; the joints three and four are of nearly equal length, linear (that is, their length being out of all proportion to their breadth); joint four is a little shorter than three, and the following gradually diminish in length till the thirteenth joint, the length of which is about double its breadth; the fourteenth is about once and a half the length of the preceding; the antennæ of *S. lignicola* are shorter, that is, if extended backwards, they would hardly reach the middle of the second abdominal segment; the fourth joint is slightly more than half the length of the third, not linear, its length being a little more than twice its breadth; the breadth of the eleventh and twelfth segments is but little more than their length; the thirteenth, or last joint, is about twice as long as the twelfth. As to the male sex, the proportional length of the third and fourth joints of *S. lignicola* ☿ is the same as in the ♀, that is, the third is almost twice

as long as the fourth, and I infer from this that the ♂ of *S. oneratus*, which I do not possess, has, like the ♀, the third and fourth joints of nearly the same length; 3d, by the mesonotum always having more or less yellow on the sides, whereas in *S. lignicola* it is altogether black, the yellow being strictly confined to the collare; 4th, by the black spot on the upper part of the abdomen having a more definite, oblong outline, the tip of the abdomen (or rather of its second segment) and its sides remaining yellow, whereas the limits of the black color in *S. lignicola* are less well defined; this color extends in the latter to the very tip of the second segment and merges into brownish or brownish-yellow on the sides; in many ♀ specimens the venter and the ventral valve are again blackish; 5th, the ventral valve of *S. oneratus* is shorter and truncate at the tip; that of *S. lignicola* ends at an angle of about 45°.

I possess five ♀ specimens of this species, obtained from the galls of *C. q. globulus* Fitch (on *Quercus alba*), from a similar gall on *Q. obtusiloba* and from that of *C. strobilana* O. S.

2. **Synergus lignicola** O. S.
Syn. *S. lignicola* O. S., Proc. Ent. Soc. Phil. I, p. 252.
S. rhoditiformis Walsh, Proc. Ent. Soc. Phil. II, p. 499.

The synonymy is admitted by Mr. Walsh himself, to whom I have communicated specimens of my *S. lignicola*. My description was drawn from rather pale specimens, and has to be corrected in the following points: 1st. The collare has a brown or black spot in the middle, which is more or less extended, being sometimes confined to a narrow brown line, in front of the angle formed by the mesonotum anteriorly and sometimes extended into a large black spot, which crosses over to the occiput, and occupies a small portion of it round the neck; the specimens bred by Mr. Walsh from the gall of *C. q. podagræ* (Q. tinctoria), and described as *S. rhoditiformis*, seem to have had this spot, usually, of a large size. 2d. The pectus is black and the middle coxæ not inserted on yellow ground as stated by me. The question of the presence or absence of "two slight subdivisions" of the last joint of the ♀ antennæ is unimportant, as it depends on the strength of the lens used and on that of the eyesight. I perceive it in *S. lignicola* as well as in the specimens of *S. rhoditiformis*, which I owe to the kindness of Mr. Walsh. His description being more detailed and accurate than mine, will have to be relied upon for determining the species, keeping, however, in view the remark about the collare, given above, and the circumstance that the ventral valve is not always of "a highly polished black," but sometimes paler. As Mr. Walsh's specimens, reared from

the gall of *C. q. podagræ* (Quercus tinctoria), seem to have had in general a darker coloring than my specimens, reared from the gall of *C. q. cornigera* (Q. palustris), it is probable that we have here again an instance of *two races* of the same species living on different trees. The differences between this species and *S. oneratus* have been detailed under the head of the latter species.

3. **Synergus læviventris** O. S. ♀.

Syn. *Synophrus? læviventris* O. S. Proc. Ent. Soc. Phil. I, p. 57.

Synophrus læviventris Walsh, Proc. etc. II, p. 494. (*Exparte.*)

0.07—0.08 long. Head reddish-brown, vertex darker, antennæ brownish-yellow, second joint not much shorter than the fourth, the third about one-third longer than the fourth; joints four, five and six of about equal length; the fourteenth or last joint is somewhat less than once and a half the length of the preceding; thorax black, moderately glossy, finely rugoso-punctate and pubescent; scutellum gibbose, with a slight, sharp, recurved, elevated margin: (thorax and scutellum in older specimens often become brownish or reddish-brown); parapsidal grooves distinct their whole length; foveæ at the base of the scutellum rather small, but distinct; pleuræ black or brownish, polished and glossy under the root of the wing, aciculate below, punctate anteriorly; first abdominal segment striate; the second segment, covering all the following, is chestnut-brown or black, paler on the under side; its shape, seen from above, is elongated-ovoid, the tip being drawn out in a point; the side-view is almost lanceolate, the tip appearing likewise pointed; held against the light, the valves of the ovipositor, as well as the ventral valve, may be seen, concealed as they are under their unusually long second joint; the ovipositor alone protrudes sometimes beyond the joint; feet brownish-yellow, extreme tip of tarsi more or less brownish; (one of my specimens has the hind tibiæ and tarsi somewhat infuscated); wings hyaline, veins pale; areolet almost obsolete, as one side of it only (which is the prolongation of the second transverse vein,) is stout and distinct; the two other sides, as well as the whole course of the cubital vein, are almost obsolete.

Four ♀ specimens, reared from the galls of *C. spongifica*, *C. centricola* and the gall on *Q. falcata*, described by me Proc. etc. I, p. 69, No. 20. It may not be useless to observe that the European *S. thaumacera* Dalm., which seems to be closely allied to our species, has the third joint of the antennæ enormously developed in the male sex.

Mr. Walsh having had the kindness to communicate to me specimens of the insects mentioned by him (Proc. Ent. Soc. II, p. 494) as *Synophrus læviventris* O. S., I convinced myself that those specimens which he had bred from the gall of *C. q. spongifica* really belong to the present species; but that the specimens obtained by him from the gall *C. q. forticornis* are the species of *Ceroptres* mentioned above, p. 51, as *C. ficus* Fitch, and closely resembling *S. læviventris* in its coloring. The remarks of this author (l. c.) have to be sifted accordingly.

4. **Synergus campanula**, n. sp. ♀.

0.08—0.10 long. Head black, except the face, which is brownish below the antennæ and brownish-yellow above the mouth; the brownish or yellowish coloring sometimes extends above the antennæ in the shape of a narrow stripe along the eyes; vertex black, little shining, smooth. Antennæ brownish-yellow, a little shorter than the body; 14-jointed (♀); the fourth joint is a little shorter than the third, the following joints gradually decrease in length; the fourteenth is about once and a half the length of the preceding joint. Thorax deep black, and but little shining, with dense, delicate, transverse rugæ, evenly spread over its upper surface, which is also clothed with a short, fine and scattered pubescence; parapsidal grooves not very deep, but distinct; a vestige of an intermediate furrow, especially visible in a certain light, towards the scutellum; two minute, parallel, glabrous lines, running a short distance from the middle of the collare, backwards; (they are visible under a strong lens only): scutellum rather large, gibbose, densely and deeply rugose; its basal foveæ rather small; pleuræ with a smooth, black, polished space, the lower part of which is finely aciculate; scapulæ yellow. First segment of the abdomen longitudinally striate; the second segment, concealing all the following, has the shape of a regular oval when seen from above; seen from the side its longitudinal diameter is about equal to the transverse one; its outline is almost that of half a circle, which has a flat arc (the dorsal side of the segment) instead of a diameter; the ventral valve or the tip of the sheath of the ovipositor are sometimes, but not always, protruding beyond the hind edge of the second segment; the abdomen is polished, black, sometimes brownish along the hind edge; feet brownish-yellow, tips of the tarsi brown; veins of the wings pale; areolet of medium size, almost obsolete, as one side of it only (the prolongation of the second transverse vein,) is short and distinct.

Three ♀ specimens reared from the gall of *Cynips q. globulus* Fitch. (white oak) and seven from a somewhat similar gall (*Quercus bicolor?*), described by me in Proc. Ent. Soc. I. p. 256.

5. **Synergus dimorphus** n. sp. ♂ ♀.

Female. 0.12—0.13 long. Head black, except the face, which is brownish-red, mixed with black, below the antennæ; mandibles (except their tip, which is black), and more or less space near their roots on the cheeks, yellowish; the brownish coloring of the face extend above the antennæ, in the shape of a narrow stripe along the eyes; vertex black, moderately shining, with sparse, broad, flat-bottomed punctures. Antennæ brownish-yellow, 13-jointed, about three-fourths the length of the body; the fourth joint is a little longer than one-half of the third; joints four, five and six are nearly of the same length; the following joints are somewhat shorter; the last joint is about equal to the two preceding taken together. Thorax black, moderately shining, with very rough, but not very dense transverse rugosities: pubescence short and very sparse: parapsidal grooves well marked, punctured at the bottom; scutellum coarsely sculptured; its basal foveæ are indistinct; the smooth space of the pleuræ is almost entirely aciculate: scapulæ brownish-yellow. First segment of the abdomen longitudinally striate; the second segment, concealing all the following, has the shape of an elongated oval, when seen from above: seen from the side, its longitudinal diameter distinctly exceeds the transverse one; the ventral valve, ending in a short, pubescent point, usually projects beyond the edge of the second segment, its angle is about 60° or 70°; abdomen polished, black;

ventral valve yellowish-brown; feet brownish-yellow; hind tibiæ and a part of the first joint of the hind tarsi infuscated: tips of all the tarsi brownish; veins of the wings brownish; areolet rather small. its structure like that of the preceding species.

Male. 0.10 long; antennæ 15-jointed, third joint excised below, fourth half as long as the third; head yellow, except a black spot on the vertex, which includes the ocelli; a part of the collare and of the pleuræ also yellow, which color seems to be variable in extent in different specimens; abdomen truncate at the tip, bell-shaped, when seen from the side; the sculpture of the head and thorax and the coloring of the feet are the same as in the female.

Numerous ♀ and two ♂ specimens, found in the box containing my collection of galls; I have not been able to ascertain what gall produced them.

This species is distinguished from *S. campanula* by its more elongated shape, the sculpture of the vertex, the coloring of the hind tibiæ, etc. Viewed from above, the abdomen is more elongated-oval than that of *S. campanula;* the sculpture of the thorax appears rough, as the wrinkles seems to be due to sharp, projecting ridges, whereas the thorax of *S. campanula*, although more densely wrinkled, has a handsomely smooth appearance; the pubescence on the thorax of the latter species is more dense, etc. Besides, the antennæ of the ♀ of *S. dimorphus* are 13 and not 14-jointed. The punctures on the vertex of this species can be perceived only under a rather strong lens.

6. **Synergus albipes** Walsh, ♂ ♀.

Syn. *Synophrus albipes* Walsh, Proc. Ent. Soc. II, p. 496, 17.

Antennæ (♀) 14-jointed, according to Mr. Walsh, the last joint one-third longer than the preceding one (the tip of the antennæ of my only ♀ is broken.) The entire body is black, except the yellow palpi, the yellowish-brown mandibles and the brownish-yellow scapulæ. The vertex is moderately shining, without any apparent punctures. The thorax is moderately shining, very finely and evenly rugoso-punctate; its pubescence short, moderately dense and very even; the parapsidal grooves but moderately distinct; the polished space on the pleuræ microscopically aciculate. The first abdominal segment is longitudinally striate; "the sheaths of the ovipositor do not project beyond the line of the back, or scarcely, and in a single ♀ only" (Walsh); the ventral valve is considerably projecting beyond the edge of the second segment; its tip at an angle of more than 45°; it is extended in a very short apicule; the shape of the second segment, as seen from the side, is nearly like that of *S. dimorphus.* Feet pale whitish-yellow, tarsal tips brown; "in a single ♂ the hind femora and tibiæ, and in a less degree the intermediate ones, are brown" (Walsh).

Mr. Walsh reared many ♂ ♀ specimens from the gall of *C. q. flocci*

Walsh (=*q. lanæ* Fitch?) in August; to him I owe the communication of some specimens.

7. **Synergus mendax** Walsh. ♀. Proc. Ent. Soc. II, 498.

A specimen, communicated to me by the author, enables me to add the following remarks to his description: 1st. The sculpture of the mesonotum is very rough and not unlike that of *S. dimorphus*, consisting apparently of transverse, projecting ridges, with intervening smooth and moderately shining spaces; only the ridges appear here more elevated and sharper, but at the same time wider apart than in *S. dimorphus* and thus the surface of the thorax is more rough, but at the same time more shining than the latter species. 2nd. The polished spot on the pleuræ is almost smooth in this species; however, under a strong lens and in an oblique light, the sculpture, common to the other species of the genus, becomes apparent here. 3rd. The general shape of the body is more elongated than in *S. dimorphus;* the abdomen, seen from the side, appears more elongated, as its transverse diameter appears, comparatively, much shorter than that of the other species. 4th. Mr. Walsh calls the ventral valve "unarmed"; but the specimen he communicated me, of this species, distinctly shows a projecting point beyond the tip of the valve.

Bred by Mr. Walsh from the gall of *C. q. podagræ* Walsh, together with *S. lignicola* O. S. (*S. rhoditiformis* Walsh).

P. S.—Since this article was presented to the Society, I have received from Mr. Bassett galls of his *Cynips hirta*. They look precisely like the galls of *Q. pisum* Fitch (=*pezomachoides* nob?) only they seem usually to be a little smaller, and the netting on the surface is more dense. In the Synoptical Table of the galls, those of *C. hirta* have therefore to be put next to those of *C. pezomachoides*. Both produce apterous gall-flies.

INDEX,

Being at the same time a synonymical catalogue of all the described N. A. *Cynipidæ*, exclusive of *Figitidæ*.

Observation.—An asterisk near a specific name signifies that I have not seen the species; an interrogation (?) that the location of the species in the genus is doubtful. Species united by brackets are probably phytophagic varieties. The subdivision of the genus *Cynips* in genera is subject to the doubts and limitations expressed in the body of my paper, and is, for this reason, only provisional. I have thought it convenient to retain the subdivision of this genus in two groups, according to the kinds of oaks which the species inhabit; this subdivision is, as I have shown, very often coincident with the generic subdivisions. although I would not affirm that it is always so.

A. GALL-FLIES.

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(Quercus).

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(Rosa.)

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Syn. Cynips dichlocerus Harris.
R. bicolor Harris.
Syn. Cynips bicolor Harris.
R. ignota O. S.
R. rosæ Linn.
R. radicum O. S.
R. verna O. S.

III. DIASTROPHUS 361

(Rubus, Potentilla.)

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D. cuscutæformis O. S.
D. potentillæ Bassett.

B. GUEST-FLIES.

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A. pirata O. S. 366
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Syn. Cynips semipiceus Harris.

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Syn. ?Amblynotus ensiger Walsh
3. *C. inermis* Walsh 369
Syn. Amblynotus inermis Walsh
4. *C. pisum* O. S. 369
Syn. Sarothrus pisum O. S.
5. *C. arbos* Fitch 370
Syn. Cynips q. arbos Fitch.
?6. *C. tuber* Fitch 370
Syn. Cynips q. tuber Fitch.

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Syn. Cynips oneratus Harris.
2. *S. lignicola* O. S. 374
Syn. S. rhoditiformis Walsh.
3. *S. læviventris* O. S. 375
Syn. Synophrus? læviventris O.S.
Syn. Synophrus læviventris Walsh (exparte).
4. *S. campanula* O. S. 375
5. *S. dimorphus* O. S. 376
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Syn. Synophrus albipes Walsh.
7. *S. mendax* Walsh 378

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Cynips q. pisum Fitch, see No. 57.....361
Cynips q. lana Fitch, see No. 45........359

ERRATA.

Page 334, line 25, for "suggests himself" read "himself suggests."
" 336, line 15, for "on" read "in."
" 366, line 11, for "A*ynipidæ*" read "*Cynipidæ*."

Duplicate
Not catalogued

THE

AMERICAN NATURALIST.

Vol. II.—MAY, 1868.—No. 3.

THE SONGS OF THE GRASSHOPPERS.

BY S. H. SCUDDER.

ALTHOUGH every one is familiar with the notes of birds, few can distinguish the different chirpings of insects, or are even aware that every kind of Grasshopper has its distinctive note. The songs of insects are neither so varied nor complicated as those of birds, but their study presents peculiar difficulties. Sounds become inaudible to many persons when they are derived from vibrations more rapid than 25,000 per second, and when the number reaches 38,000, the limit of human perceptibility is attained: thus, the shrillness of a note may prove a hinderance to its study. This is illustrated by Tyndall in his recent book on Sound. He writes: "Crossing the Wengern Alp with a friend, the grass on each side of the path swarmed with insects, which, to me, rent the air with their shrill chirruping. My friend heard nothing of this, the insect world lying beyond his limit of audition."

Another and universal obstacle lies in the delicacy or feebleness of the notes of some species; to distinguish them

clearly, one must bring his ear to within a few feet, or even inches of the insect during its stridulation,—a process which requires great caution lest the shyness of the little violinist should overcome his egotistic love of song. The observer must walk quietly toward the sound until it ceases, and wait motionless for its renewal; the direction of the chirping can then easily be determined, although its distance is deceptive. After drawing an imaginary line towards the spot from whence the sound proceeds, cautious steps must be taken around the arc of a wide circle until another line is fixed at right angles to the first, and the location of the songster approximately determined. Then walking quickly but quietly to within five or six feet of the insect, the observer will fall upon his hands and knees, and produce a quill edge and file, which, on being rubbed together, imitate, with great exactness, the desired note. He will commence his mock stridulation after a short delay; at first the sounds must be subdued and separated by considerable intervals, then loud, and repeated in quick succession; usually a response is heard before a minute has elapsed, and sometimes it comes at once. When the insect has forgotten his fears and begins to stridulate violently, the observer may cease operations and carefully approach him. In this way one can place himself within a few inches of any species living in the grass.

Grasshoppers stridulate in four different ways: first, by rubbing the base of one wing-cover upon the other, using, for that purpose, the veins running through the middle portion of the wing; second, by a similar method, but using the veins of the inner part of the wing; third, by rubbing the inner surface of the hind legs against the outer surface of the wing-covers; and fourth, by rubbing together the upper surface of the front edge of the wings and the under surface of the wing-covers. The insects which employ the fourth method stridulate during flight,—the others while at rest. To the first group belong the Crickets; to the second

the Green or Long-horned Grasshoppers; to the third and fourth, certain kinds of Short-horned or Jumping Grasshoppers. The sounds produced by the different groups vary in pitch, those of the crickets being shrillest and the others following in the order just given. With but few exceptions the males alone sing.

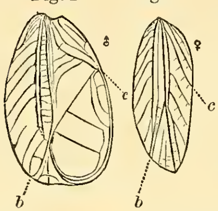
The notes of the Cricket—called by the French "cri cri" on account of its song—may be heard near Boston* from the middle of June until November; further north they do not appear until much later in the season. Their note is *crrri*, and the rapidity with which it is uttered varies even in the same strain; sometimes it is as slow as two notes a second, at others it is twice as rapid. The note is sharp and shrill, and appears to be pitched at E natural, two octaves above middle C. Sometimes two choirs of these insects may be heard at once, the individuals of each choir chirping simultaneously, but one choir more rapidly than the other; most of the time this produces a sort of discord, but, as they occasionally harmonize, one hears cycles of accordance and discordance, often of remarkable uniformity and duration.

The Spotted-cricket (*Nemobius vittatus*) appears simultaneously with the Black-cricket (*Gryllus niger*). The chirping of the two insects is very similar, but that of the former may be better expressed by *r-r-r-u*, pronounced as though it were a French word. The note is trilled forcibly, and lasts a variable length of time. One of these insects was once observed while singing to its mate. At first the song was mild and frequently broken; afterwards it grew impetuous, forcible, and more prolonged; then it decreased in volume and extent until it became quite soft and feeble. At this point the male began to approach the female, uttering a series of twittering chirps; the female ran away, and the male, after a short chase, returned to his old haunt, singing with the same vigor but with frequent pauses; at last, finding all persuasion unavailing he brought his serenade to a close.

* All my illustrations are drawn from New England insects.

In September and October, the White Climbing-cricket (*Œcanthus niveus*, Fig. 1, left wing-cover of male, Fig. 1 *a*, the same of female*) is found on the leaves of low trees and bushes. It makes a uniform note, exceedingly shrill but attenuated.

Fig. 1. Fig. 1 *a*.



The peculiar development of the wing in stridulating Orthoptera is nowhere seen to better advantage than in this insect. In the female, the veins of the central field run nearly parallel to the border; in the male, they cross the wing in various directions, and either converge toward the point of stridulation on the inner border of the wing, where the inner and central fields meet, or act as supports to the converging veins.

All these insects belong to the first class. There are many species in the second group (the green or long-horned grasshoppers), but a few examples will suffice. These insects, like the crickets, sing both by day and night, but, unlike the latter, their day-song differs from that of the night. On a summer's day, it is curious to observe these little creatures suddenly changing from the day to the night-song at the mere passing of a cloud, and returning to the old note when the sky is clear. By imitating the two songs in the daytime, the grasshoppers can be made to respond to either at will; at night, they have but one note.

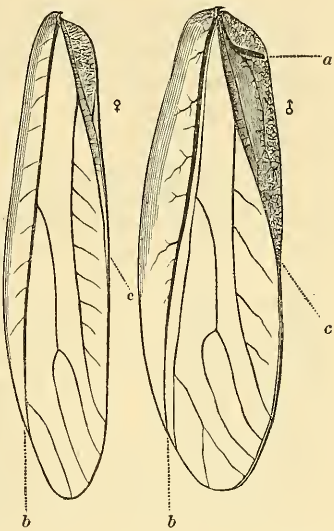
The previous illustrations showed that the stridulating organ of crickets occupied the middle field of the wing; in the green grasshoppers, on the contrary, it will be found in the inner field; here, too, the relative size of the inner field is nearly the same in both sexes, but the stout, curved vein of the male is altogether wanting in the voiceless female.

One of them, the *Phaneroptera curvicauda* (Fig. 2, male;

* In all the illustrations, the dotted lines show the limitations of the different fields of the wing; *a* represents the "file;" *b* points at the line of separation between the costal (or outer) and central fields; *c*, at that point between the central and inner fields.

Fig. 2 *a*, female), prefers to sing in the night. His day-song is *bzrwĭ*, and lasts one-third of a second; the night-song consists of a repetition—ordinarily eight times—of a note which sounds like *tchw*. This is repeated at the rate of five in three-quarters of a second, making each note one-half as long as that of the day.

Fig. 2 *a*. Fig. 2.



The song of the common Meadow-grasshopper (*Orchelimum vulgare*) is more complicated. Commencing with *ts*, it changes almost instantly into a trill of *zr:* at first there is a crescendo movement which reaches its volume in half a second; the trill is then sustained for a period varying from one to twenty seconds, and closes suddenly with *p*. This strain is followed by a series of staccato notes, sounding like *jip;* they are one-eighth of a second in length, and are produced at one-half second intervals. The staccato notes and the trill alternate *ad libitum*. The night-song differs from that of the day simply in its slower movement; the pitch of both is at B flat, two octaves above middle C.

A conical-headed grasshopper (*Conocephalus robustus*), found near the seashore in the southern part of New England, makes the salt marshes resound with its incessant, shrill din. The resemblance of its song to that of the harvest-fly is quite striking; at a distance, the note seems to be perfectly uniform; close at hand, one can hear it rising and falling rhythmically, two and a half times a second, accompanied by a loud droning noise.

There are numerous kinds of jumping grasshoppers which stridulate in the daytime only. They do this by the aid of

the hind legs, rubbing their thighs against their wing-covers; every movement of the fiddle-bow produces a short note, and the uniformity with which each species plays its own song is quite remarkable. One kind (*Stenobothrus curtipennis*) produces about six notes per second, and continues them from one and a half to two and a half seconds; another (*S. melanopleurus*) makes from nine to twelve notes in about three seconds. In both cases the notes follow each other uniformly, and are slower in the shade than in the sun.

The stridulating apparatus of the jumping grasshoppers is of a very different character from that of the green grasshoppers. In *Arcyptera lineata* (Fig. 3, left wing of male; Fig. 3 *a*, left wing of female), for example, it is situated in the central field of the wing, which is of about the same size in both sexes; some of the veins in the centre of the wing (*a*, enlarged in Fig. 3 *b*) have a rasp-like surface upon which the hind thighs are scraped up and down, producing monotonous, nearly uniform notes.

Fig. 3.

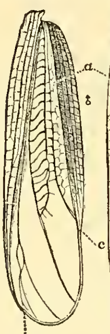


Fig. 3 *a*.

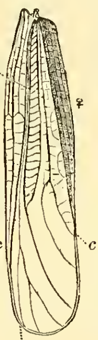
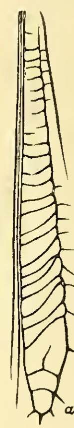
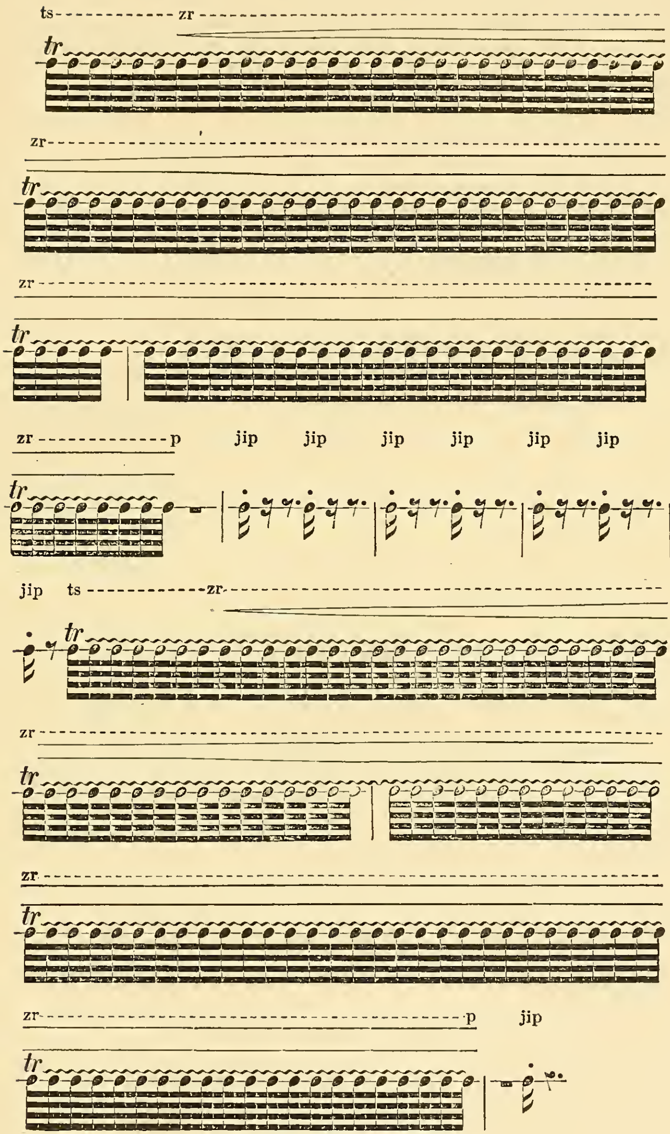


Fig. 3 *b*.

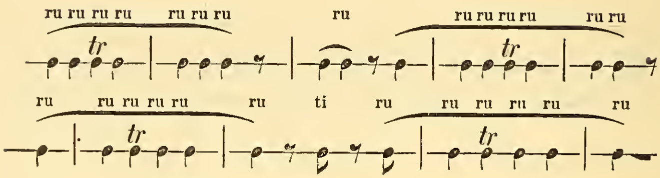


The grasshoppers which stridulate during flight, by the contact of the wings and wing-covers, belong mostly to the genus *Œdipoda*; in many of them the wings are variegated with brilliant colors. The sound which they make seems to be under the control of the insects, for they often omit it when alarmed. Some species produce a uniform, rattling noise during the whole of their undeviating flight; others make it only during the intervals of flight, and seem to stridulate more at will. The flight of the latter is more sustained, they are capable of changing their course, and at each turn emit a crackling sound of short duration.

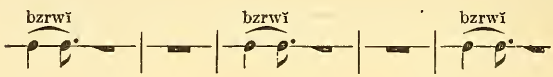


Note of Orchelimum vulgare.

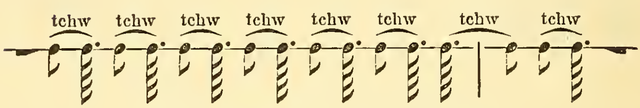
Note of Gryllus neglectus.



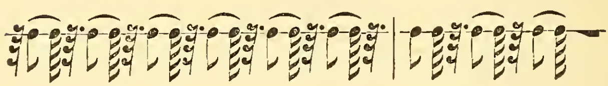
Note of Nemobius vittatus.



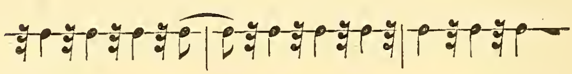
Note of Phaneroptera curvicauda by day.



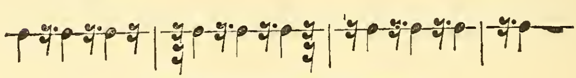
Note of Phaneroptera curvicauda by night.



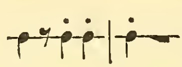
Note of Stenobothrus melanopleurus in the sun.



Note of Stenobothrus melanopleurus in the shade.



Note of Stenobothrus curtipennis.



Note of Arcyptera lineata.

Boston Public Library
from the Author.

17 F.

From the Proc. Bost. Soc. Nat. Hist., XV, p. 381-384.

Anisopteryx vernata distinguished from A. pometaria.

By B. Pickman Mann.

The question of the difference between *Anisopteryx vernata* and *Anisopteryx pometaria* having been raised, I have looked over my notes, and made some new observations, with the results contained in this paper.

In the following descriptions I have drawn as much as possible from Harris' Treatise on Some of the Insects Injurious to Vegetation, and have indicated by italics the portions so adopted.

First, I give the characters which, as far as I know at present, are common to both species.

The antennæ of the male have a very narrow and almost downy edging, on each side, hardly to be seen with the naked eye. The feelers are minute and do not extend beyond the mouth. The tongue is not visible. The wings are large, very thin, and silky; and, when the insect is at rest, the fore wings are turned back, entirely cover the hind wings, and overlap on their inner edges. The female is wingless, and its antennæ are short, being about half the length of the body, filiform, and *slender. Its body approaches to an oval form*, Harris adds, *but tapers and is turned up behind.* I am not able to say whether this character is common to both species or not.

I find the following differences between the species: —

Anisopteryx vernata.	*Anisopteryx pometaria.*
The first seven rings of the abdomen of both sexes with no spines upon the back.	The first seven rings of the abdomen of both sexes bear each upon the back two transverse rows of stiff red spines pointing towards the end of the body.
Fore wings of male ash-colored, with	*Fore wings of male ash-colored* or brownish-gray;
a distinct whitish spot on the front edge, near the tip;	the *whitish spot* found on the fore wings of *A. vernata* is *wanting.*
[*fore wings*] *crossed by two jagged, whitish bands; the outermost band has an angle near the front edge. The white bands are often entirely wanting, in which case only the whitish spot near the tip remains.*	*The whitish bands* found on the fore wings of *A. vernata* are *wanting*, out there is a jagged, submarginal white band on the upper side of the fore wings in most specimens.
Along the sides of the whitish bands *there are several blackish dots*, each on a nervure, and all generally connected together by a dusky band which includes them, and runs on that side of each whitish band which is towards the other. These bands remain visible when the whitish bands are wanting.	*There are three interrupted, dusky lines across the fore wings*, instead of two lines, as in *A. vernata.* Sometimes these lines are only indicated by dark spots on the front edge of the wing, and by blackish dashes at the crossing of median nervure; rarely are they very distinct throughout their whole extent.

Within the angle of the outermost whitish band, near the front edge, *there is a short, faint, blackish line*, following a nervure; *and there is a row of black dots along the outer margin, close to the fringe.*

There is *an oblique, blackish dash near the tip* of the fore wings, crossing a nervure; and there is a distinctly interrupted or nearly uniform continuous line of blackish along the outer margin, close to the fringe.

The hind wings are pale ash-colored, or light gray, with a faint blackish dot near the middle.

The hind wings are pale ash-colored, or very light gray, with a faint blackish dot near the middle.

In most specimens a curved white band is plainly visible on the hind wings, about half way between the middle and the end.

The white band found on the hind wings of *A. vernata* is wanting.

The outermost white band of the fore wings, with its angulation, and the band of the hind wings, are also visible on the under side of the wings. Within the angulation is a brown or blackish spot on the costa.

On the costa, opposite the beginning of the outermost dark band of the upper surface, and on the edge of the disk, are dark spots on the lower surface of the wings. Along the median nervure beneath is a dark line. These marks are sometimes indistinct.

The wings expand about one inch and a quarter (32 millimeters), varying between 26 and 34 millimeters, and predominating at 30 millimeters.

Of a rather smaller size than *A. vernata*, varying between 22 and 33 millimeters,[1] and predominating at 29 millimeters.

Antennæ of the female naked.

Antennæ of the female pubescent.

Abdomen not terminating in an ovipositor, rather bluntly tapering behind.

Abdomen terminating in a retractile ovipositor, rather acutely tapering behind.

Whole body and legs of the female smooth, clothed with glistening brown and white truncate scales intermixed, giving it an appearance of uniform shiny dark ash-color above and gray beneath.

Whole body and legs of the female pubescent, clothed with whitish and brown or black dentate scales or hairs; general coloration not uniform. A black band along the middle of the back of the abdomen, often interrupted on the second to seventh rings; with a whitish patch each side of its front end; the spines frequently giving a reddish appearance to the part they occupy.

Crest of prothorax and mesothorax black.

[1] One specimen in my collection with all the other characters except size, measures 38 millimeters.

Length of the female 6–10 mm.

Of 16 dated specimens of the male in my collection, 12 were taken in October or November, and 4 in March or April. The two spring specimens in my collection now are among the most strongly characterized I have.

Of several hundred females in my collection, four were taken in April and the rest in November.

Length of the female 5–8 mm.

Of 16 dated specimens of the male in my collection, 1 was taken in March and 15 in April.

Of nine females in my collection, all were taken in April. Among several hundred females of *A. vernata* taken in November I do not find one female of this species, wherefore I think it probable that this species is found only in spring.

I must acknowledge myself indebted to Mr. H. K. Morrison for the suggestion that I should find *A. vernata* a fall species and *A. pometaria* a spring species. It seems as if the occurrence of *A. vernata* in spring might be explained by considering the spring specimens as belated. The necessity of applying the name *vernata* to a fall species illustrates the danger of attempting to give names characteristic of season or locality.

I hope observers will take note next spring whether the eggs of *A. pometaria* do not want the jug-like shape and lid-like upper end which are seen in the eggs of *A. vernata*, also whether the eggs are not laid separately in chinks of bark, and whether their number is not about sixty, instead of over two hundred, as in *A. vernata*. I have only seen apparently immature eggs in the female.[1]

[1] A few days after the presentation of the above communication Mr. Morrison informed me that he had lately seen a female *A. pometaria* thrust her ovipositor in between the chinks of bark of the apple-tree, and lay an egg there. He pulled off the bark and found eggs beneath. He had also seen the female thrust her ovipositor into the crack of a board fence, and lay an egg there. He did not observe the shape of the egg.

Corrigenda, to be explained in a subsequent communication: —

p. 384, lines 16–18. Omit the whole sentence from "The necessity" to "locality," inclusive.

pp. 382–384. Instead of *vernata* read *pometaria*, and instead of *pometaria* read *vernata*.

Bo

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card
b